National comprehensive reviews on Environmental and Sustainability Research and Innovation needs, Funding and Science Policy and Practice Interactions

CASRI Deliverable 2.1

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CASRI

Collaborative Action coordinating and enhancing systemic, actionable and transversal Sustainability Research and Innovation

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	31.01.2025	CASRI Core-Group		Review by core group
0.2	12.02.2025	Deltares	Second draft	Review by International Advisory Board (IAB) and National key Stakeholders (NKS)
0.3	27.02.2025	Deltares	Final version	Revised based on review by Core Group, IAB and NKS
1.0	05.03.2025	UBA	Final version	Final format.

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KEYWORDS

Environmental and Sustainability Research and Innovation needs, R&I, funding schemes, Science-Policy-Practice Interaction, SPPI, Resilient, net-zero, circular production systems, Biodiversity, Climate Change, Sustainable urbanisation, Nature, environmentally friendly energy transition

ABBREVIATIONS

AI	Artificial Intelligence
CG	Core Group
CSA	Coordination and Support Action
D	Deliverable
EC	European Commission
EEA	European Environment Agency
EGD	European Grean Deal
ES R&I	Environmental and Sustainability Research and Innovation
EPA	Environmental Protection Agency
EU	European Union
HEU	Horizon Europe
IAB	International Advisory Board
LCA	Life Cycle Analysis or Assessment
MS	Member State
Ms	Milestone
NC	National Contacts
NKS	National Key Stakeholders
R&I	Research and Innovation
RDI	Research, Development and Innovation
SDGs	Sustainable Development Goals
SPPI	Science, Policy and Practice Interaction or Interface
SRIA	Strategic Research and Innovation Agenda
T	Task
WP	Work Package

PART I: Introduction and methodology

1 Introduction

1.1 CASRI Background and approach

This report presents the methodology for, and outputs from 14 national comprehensive reviews within the CASRI project. Participating country or regions are: Austria, Basque Country (Spain), Bulgaria, Finland, Flanders (Belgium), France, Germany, Ireland, Italy, Montenegro, The Netherlands, Slovakia, Switzerland and Wales. Each country / region has, under guidance of a National Contact (NCs) and together with their National key Stakeholders (NKS), collated information on: 1) Environmental and Sustainability (ES) Research and Innovation (R&I) needs, 2) promising funding schemes for ES R&I, 3) good practices and gaps in Science Policy and Practice Interactions (SPPI) and 4) recommendations to setup CASRI's Strategic Research and Innovation Agenda (SRIA).

CASRI's aim is to collaboratively develop a bottom-up ES SRIA. The SRIA is meant to become a guiding document for the national EPAs involved in the project. The overall goal is to stimulate collaboration, including common funding, regarding the identified important topics in the upcoming years by the involved EPAs and partners. It is meant to be complementary with the European ES R&I funding frameworks (in particular Horizon Europe and future framework programmes). Together, the SRIA and these funding frameworks should facilitate sustainable development in Europe in times of multiple crises.

This report concludes the first of the four phases in CASRI. The four CASRI phases (Figure 1) are:
(1) Comprehensive national reviews to gather, on a national level, elements for the SRIA,
(2) Identification of transnational commons from the national comprehensive reviews,
(3) Match of prioritized topics and funding opportunities and gaps,
(4) Implementation Actions for common research funding plans.

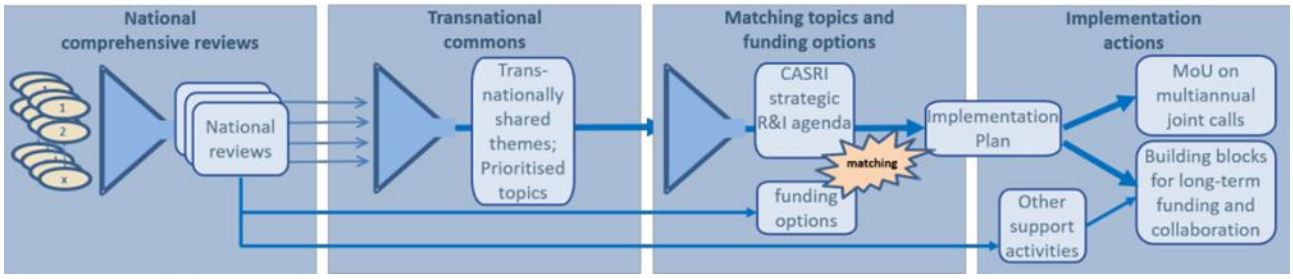

FIGURE 1 THE CASRI APPROACH

The CASRI workflow and stakeholder interaction is further described in CASRI D6.1 "Co-design workflow methodology defining coherent engagement of stakeholders throughout WPs 2-5" (Firus et al., 2024).

1.2 CASRI Themes

Europe's approach to ES R&I is multifaceted, addressing various themes and challenges through both national and regional initiatives. As a starting point of the assessment of ES R&I needs, CASRI focusses on four key themes that link several Sustainable Development Goals (SDGs[1]) and intersect the major existing funding foci of Horizon Europe (HEU), i.e,: 1) Resilient, net-zero, circular production systems, 2) Biodiversity and climate, 3) Sustainable urbanisation, 4) Nature & environmentally friendly energy transition. These CASRI themes are described below (Table 1).

TABLE 1 CASRI ES TOPICS AND SDGS

CASRI Theme	Link to global challenges and HEU Missions	Primary links to SDGs
Resilient, net-zero, circular production systems	Climate Mission + Clusters 4, 5, 6 + Pillar III, EIT KIC Raw Materials, Manufacturing	
Biodiversity and Climate	Climate Mission (also Soils, Oceans, Cities), Clusters 5 and 6	
Sustainable urbanisation	Cities, Climate, Soils Missions, More or less all 6 Clusters, NEB initiative	
Nature & environmentally friendly energy transition	Climate Mission (also Soils, Oceans), Clusters 5 and 6	

Resilient, net-zero, circular production systems

Transforming Europe's production system from a linear, fossil-based system to one that is resilient, emission neutral and circular within the next few decades lies at the heart of the European Green Deal. The main challenge is to balance the differences in strategic competitive advantages and impacts created and caused by climate neutrality (OECD, 2023), circularity (EASSHN, 2024) and resilience (ECA, 2024) objectives. As Europe is the tone setter for a levelized playing field across many industries and value chains, with many involved (supra)national institutions operating at the same time, this poses a great responsibility in mainstreaming (1) environmental sustainability along various (2) administrative levels and (3) actor bases.

Many of the research and innovations needs foreseen for the transformation of (European) industrial value chains are financed through EU instruments (e.g. Horizon Europe, Innovation Fund) or via individual countries (e.g. through Important Projects of Common European Interest, IPCEI) (DG RTD, 2023). Various evaluations have indicated that key flagships in delineating "sustainability" are rather narrowly formulated along techno-economic foci, favouring mostly incumbent actors in top-down funding schemes (EASSHN, 2024; ECA, 2021). With the many interlinkages and interdependencies across production systems and countries, successful implementation of multi-objective policies requires paying greater attention to the links across sectors, across societal actors and countries. Hints of these attempts of holistic understanding may thus be a first frontier of maturing sustainability understanding (Le Blanc, 2015; Sianes et al., 2022).

[1] https://sdgs.un.org/goals

Biodiversity and Climate

Climate change and biodiversity loss are deeply interconnected global challenges. Climate change can exacerbate biodiversity loss by altering habitats and ecosystems, while the loss of biodiversity can reduce the resilience of ecosystems to climate change and undermine nature's ability to regulate emissions. For example, deforestation contributes to climate change by releasing stored carbon dioxide, and climate change can further degrade forest ecosystems. Likewise, rising sea temperatures and acidification caused by carbon emissions affect marine biodiversity, which in turn impacts fisheries and livelihoods of the coastal communities. Focusing on both climate change and biodiversity loss simultaneously is essential both because of potential for synergistic solutions and danger of trade-offs. Many strategies to combat climate change, such as reforestation, can also help to preserve biodiversity. On the other hand, nature-based solutions originating from rich biodiversity can be a vital part of climate adaptation. Addressing both issues together ensures a more comprehensive and effective response, enhancing the resilience of both natural and societal systems. Integrating climate and biodiversity goals supports sustainable development, ensuring that economic growth does not come at the expense of the environment. Consideration of cross-border impacts of national activities is important in order to avoid risks of externalising climate emissions or biodiversity loss through long value-chains.

Sustainable urbanisation

Cities are faced with a number of environmental challenges. The impacts of climate change, demographic change, resource demands, mobility needs, quality of life, among others, are complicated and interrelated. Cities are at the same time generally an environmental stressor in regards to being a concentration point of pollutants as well as energy and resource consumption. This is coupled with a high economic pressure on inner-city land to be developed and the long-term lock-ins of buildings and infrastructure which follow.

Sustainable urbanization is a normative goal in that it aims for aspects such as climate protection, climate adaptation, provision of recreational areas, promotion of urban nature, improving air quality as well as reducing noise pollution. Such goals have an impact on the environment, on human health, but also on social aspects such as community identity, participation and the quality of life. Sustainable urbanization is to be measured in terms of its environmental, social and economic impact. As such, the sustainable transformation of cities must consider overarching questions of what is socially just development, how can health for all be supported, where should action be prioritized, among other concerns. Dedicated research and innovation activities are in need to address sustainable urban development as a future research field.

Regarding the CASRI triangle (Figure 2) the various sectors involved in the planning, building and maintenance of urban centres well reflects the systemic level of CASRI considerations. The field of integrated urban development aims for the consideration of various expert advice and regulatory compliance. An example can be seen in multifunctionality of urban spaces, which aims for the layering of various user demands and sectoral interest upon a space. On the transversal level, the coordination which takes place between stakeholders considers various responsibilities (some formal, others informal) and is situated on various spatial levels of governance (from the object/neighbourhood all the way to the international). The forms of collaboration available and the insights gained from these can inform research agendas.

Action requires identifying specific cases to address and the desired impact aimed for; from identifying and breaking obstacles for sustainable construction all the way to policy instruments for the implementation of the sponge city concept. Action is also required when it comes to dissemination and learning about implementation in differing European contexts. By considering these various aspects, CASRI will look to further inform research on the topic of sustainable urbanization.

Nature & environmentally friendly energy transition

The transition to nature- and environmentally friendly energy systems is essential for transformative change. While renewable energy sources offer a pathway to combat climate change, it may result in conflicts with other essential environmental targets, such as biodiversity, zero pollution or circular economy. These goals must be pursued in parallel to ensure a sustainable future, because all targets are of equal importance. While much progress has been made in addressing the resource and circular economy aspects of transition, the integration of biodiversity targets is lagging far behind. Renewable energy infrastructure, though vital for climate goals, can have unintended environmental consequences, particularly on ecosystems or wildlife. Balancing the diverse environmental objectives is not an easy task, as setting clear, quantitative targets remains difficult, and regional differentiation is often necessary due to varying local contexts. A successful energy transition requires not only technological innovation but also social acceptance, transdisciplinary research, and scalable policies. Renewable energy projects, such as wind and solar power, can sometimes create opportunities for biodiversity enhancement, especially in intensively used agricultural areas. However, more research is needed to understand these synergies and develop guidelines for cities and regions to balance renewable energy expansion with environmental preservation.

The CASRI triangle (Figure 2) reflects the systemic approach to the nature- and environmentally friendly energy transition. The energy transition field prioritizes integrating expert advices to address target conflicts and ensure regulatory compliance. At the transversal level, coordination among stakeholders, involving various responsibilities and spanning different spatial levels of governance, along with the insights gained, can inform and shape research agendas. Action requires the development of a Code of Conduct on how to deal with topics such as “Energy Transition” which involve conflicts of interest (process- and content-wise) and requires the development impact scenarios of energy transition on the regional level. Cities and municipalities in particular need guidelines on which cross-sectoral measures they can take in their areas of competence (measures, monitoring). Once developed, this methodology is transferable to a larger scale. By considering these aspects, CASRI aims to further advance research on the topic of nature- and environmentally friendly energy transition.

CASRI themes and systemic, actionable and transversal knowledge

When zooming in to actual locations or regions, these four themes meet each other, e.g. in their competition for land but also by their common subjection to trends such as digitalization. CASRI therefore not only identifies challenges and opportunities for innovation *within* the CASRI topics, but also on the cutting edges *between* them. This shall ensure that efforts align with the broader goals of sustainability so that new challenges, requesting new knowledge, innovations and adapted policy and practice, can emerge. CASRI focuses on R&I that is systemic, actionable and transversal (Figure 2) to facilitate sustainable development and that is of high relevance to support national policy makers and societies to address the Global Challenges and SDGs.

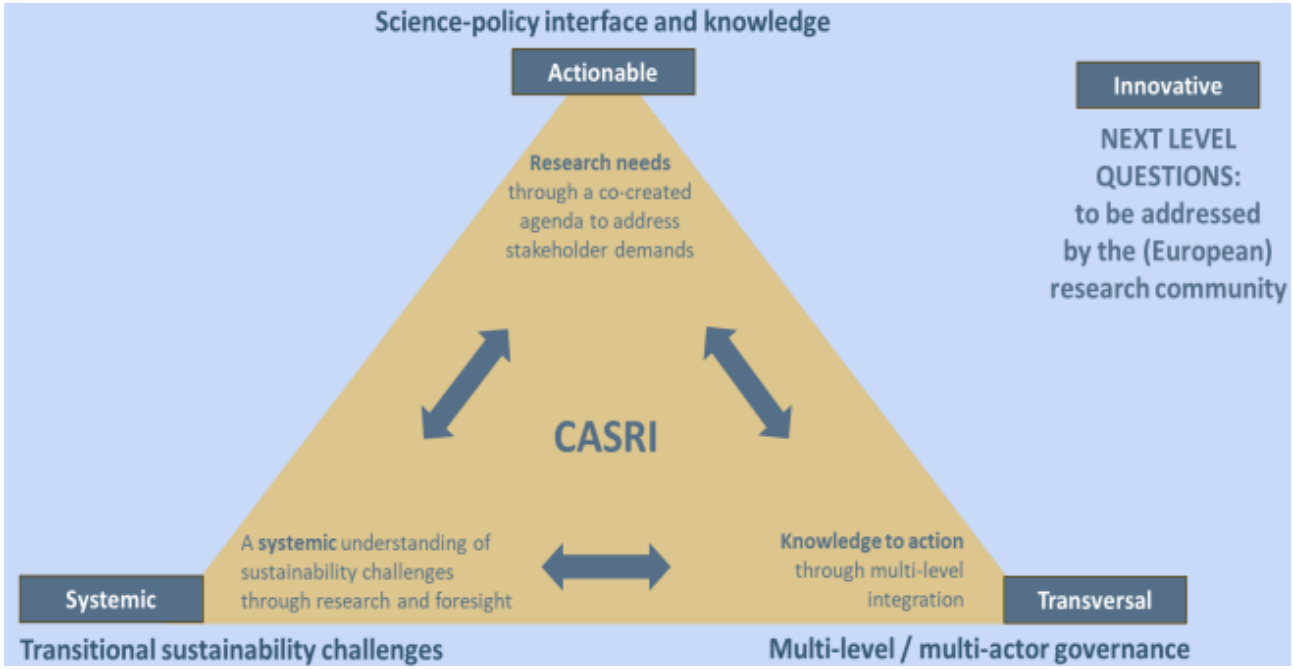

Figure 2 ***THE CASRI TRIANGLE***

2 Methodology

2.1 Methodology to obtain the national comprehensive reviews

In the first phase of the CASRI approach (i.e. to obtain the national comprehensive reviews on ES R&I needs, funding and SPPI – figure 1) three steps were taken. Each National Contact (NCs):

1. *identified* about 20 relevant *National Key Stakeholders* (NKS) in their country, ensuring they represent the different backgrounds and themes identified in CASRI (section 1.4);
2. *collated* the *information* needed by:
    a. performing a *desk study* on the CASRI themes, comprising existing R&I agendas, existing and promising national funding schemes as well as relevant aspects on the Science Policy Practice Interface (see Appendix B for the consulted literature);
    b. *interviewing* the selected NKS, according to a semi-structured interview protocol (Appendix C);
3. *organised* a *workshop* with NKS to review, synthesize and prioritize the gathered information, following a general workshop template, to be tailored to national specificities (Appendix D).

The results of these national collations are a core element and basis to feed into the next phases of CASRI. Phase 2 intends to find transnational commons within, between and outside the CASRI ES R&I themes. This is led by 4 CASRI Theme Leaders. The transnational commons will be reported and a selection of topics will be made for which a matchmaking process with NKS will be setup. This will be taken up in the CASRI Strategic Research and Innovation Agenda (SRIA) in phase 3. For the topics on the agenda, funding opportunities are mapped and finally, in phase 4, a plan with activities and recommendations for the implementation of the CASRI SRIA is set up to ensure collaboration also after CASRI's lifetime. (More details are available in Firus et al., 2024 and Bartke et al., 2018).

2.2 Stakeholder involvement

In the figures below an overview is given of the NKS involvement in this phase of CASRI. In total, over 300 NKS were involved in the 14 countries / regions. A balanced gender diversity was monitored in line with the CASRI *Ethics, gender and diversity plan* (Bartke, 2014). In the figures below, a single NKS can represent more than 1 kind of organisation, sector or have expertise on multiple themes.

Funders, end users and knowledge providers

Figure 3 shows that most organizations are either providers and/or end users of knowledge. Although well represented (86 NKS qualify their organisation as such), a minority is considered funder.

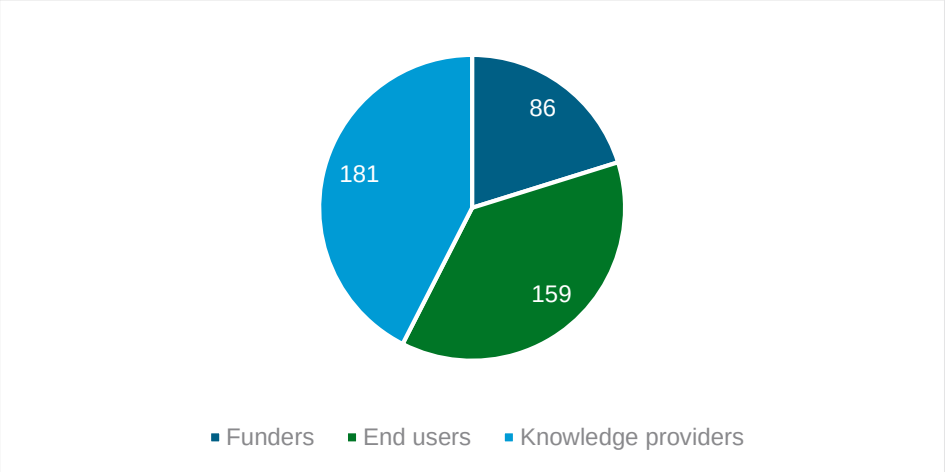

FIGURE 3: NKS TYPES REGARDING KNOWLEDGE

Sector: government, research, industry, NGO

As indicated in Figure 4, over a third of NKS represent government organizations. Almost a third are research organizations, i.e. university or other research institutes, think tanks, or environmental protection agency (EPA's). Societal stakeholders and practitioner also represent one third, incl. NGOs and industry.

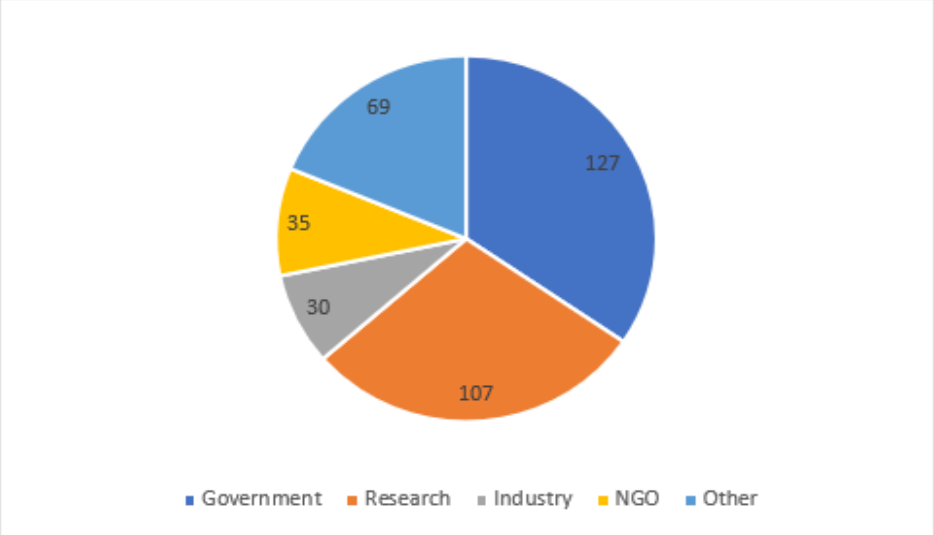

FIGURE 4: NKS SECTORS

Expertise, or CASRI-themes

Figure 5 shows the NKS expertise regarding CASRI's four main sustainability research and innovation themes. Almost a third of the NKS states that its main area of expertise aligns closest to the 'biodiversity and climate' theme. Almost a quarter indicates 'sustainable urbanization' as their main expertise. The same goes for the 'circular economy' or, more specifically 'resilient net-zero circular production systems' theme. With only one out of six NKS reporting it as their main theme, 'energy transition' is somewhat less well represented.

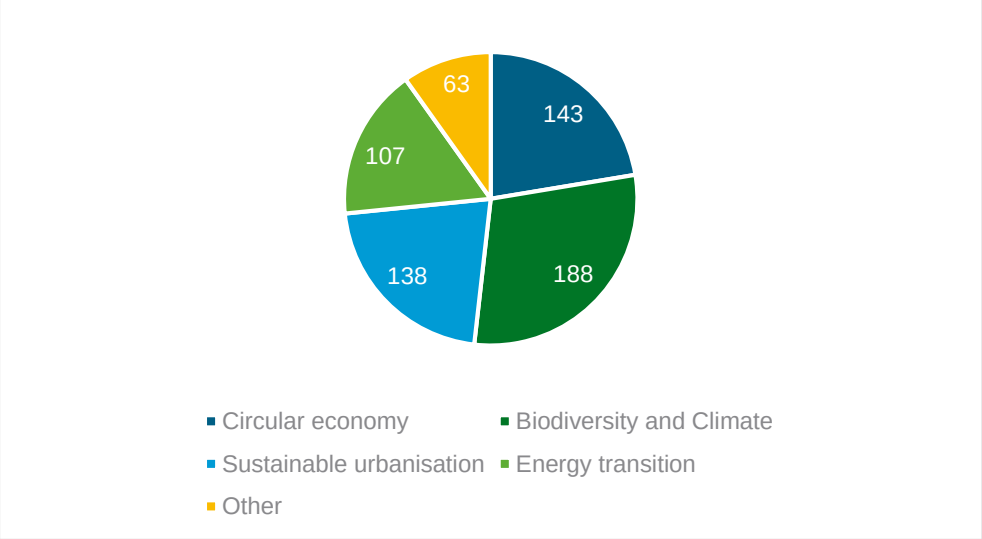

FIGURE 5: NKS EXPERTISE REGARDING THE CASRI-THEMES

Current positions and responsibility of involved NKS

Finally, the position of involved NKS was indicated, based on their seniority (Figure 6).

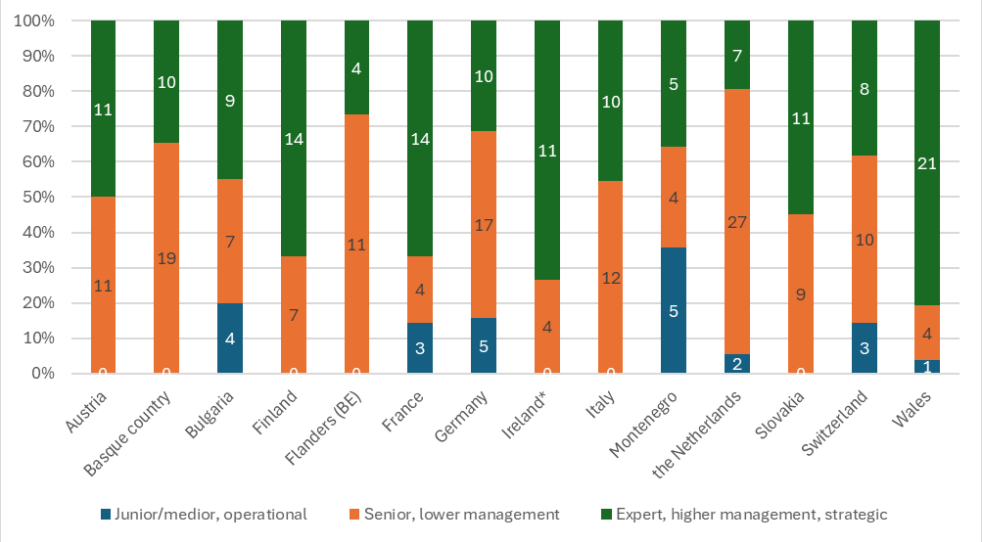

FIGURE 6 POSITION / RESPONSIBILITY OF THE INVOLVED NKS OER COUNTRY / REGION

**For Ireland: this overview of involved NKS includes a number of bilateral meetings conducted to finalise the EPA Thematic Research Priorities 2024-6, which informed the National Review for Ireland*

2.3 Reflection on the methodology

The NCs were asked to reflect on the followed methodology[2] of this first phase in CASRI. This resulted in the following points of attention:

1. **Stakeholder inclusion and representation:** The inclusion of stakeholders from diverse sectors, such as public administration, research institutes and industry, was a key aspect of the approach. The NKS selection process aimed to avoid selectivity biases. As indicated in Figure 4: NKS sectors in general a good balance was achieved, however with a varying focus in the different countries, e.g. regarding inclusion of different levels of public administration. Mainly representatives from federal administration and national organizations were selected, with some, but limited inclusion of decentral authorities, such as local officials due to their relevance to the CASRI theme of sustainable urbanization. This can be an issue, for example when funding is organized locally or regionally.
2. **Interviews:** In several cases, the NCs indicated that the timeframe for the interviews was (too) limited when compared to the amount of questions and CASRI topics that were included in the interview template (Appendix C). Therefore, in some cases, NCs have chosen to pass over some parts. As recommended in the interview template, the parts to pass over could be a topic where the NKS was less familiar with. But in other cases, other parts were left out in all interviews, such as the networks where NKS were involved in, or recommendations to CASRI. This is indicated in the country reports when it occurred.
3. **Workshop structure and participation:** The NC's received a workshop template for national workshops to review, synthesize and prioritize the interim results coming from the desk studies and interviews (appendix D). However, the NC's were free to adjust this template to meet national specificities. In this way, the NCs could design the stakeholder workshops in such a way that NKS participation was ensured, e.g. through a condensed duration, a thematic focus that reflected the intersections in the expertise and interests of the participants and engaging methods that were familiar to the NCs and NKS. Not all topics raised in the interviews could be validated in the workshops due to time constraints. However, the workshops provided a deeper understanding and unified perspective on key issues. They ensured that the information collected during desk research and interviews was comprehensive and complete and that stakeholder were effectively informed. In most cases, the timeframe of the workshops was sufficient to generate common insights and ensure broad stakeholder interaction and participation. This makes it a valuable step in the process.
4. **NKS engagement**: Maintaining high levels of engagement from stakeholders throughout the process was, and stays crucial in CASRI. Future workshops with stakeholder participation should address the interests and needs of stakeholders and offer them added value, such as networking opportunities with interesting other participants, the EU Commission or the EEA. This could already be proactively included in the invitations.

[2] Note that some countries or regions have followed a different approach, matching their own ongoing processes with national stakeholders. In some cases, no interviews were held, just workshops. In other cases, this was the other way around. Where this was the case, this is indicated in the reflections on the workflow as described in each of the country reports (sections x.5).

3 This report / reading guidance

This report contains 2 parts. Part I contains the introduction and methodology of the CASRI project. Part II presents the reviewed, synthesized and prioritized results of the information collated in each of the 14 participating countries and regions (Austria, Basque Country (Spain), Bulgaria, Finland, Flanders (Belgium), France, Germany, Ireland, Italy, Montenegro, The Netherlands, Slovakia, Switzerland, Wales (UK)). Each national report starts with an executive summary (in national language where relevant, and English), followed by the synthesized results from the desk study, interviews and national workshop. The reports end with recommendations for CASRI and reflection on the workflow (Table 2).

TABLE 2: CONTENTS OF EACH NATIONAL REPORT

No	Chapter	Content
	Country specific abbreviations	If applicable
	Executive summary	National language and English
X.1 X.1.1. X.1.2. X.1.3. X.1.4. X.1.5. X.1.6.	Reviewed, synthesized and prioritized environmental and sustainability R&I needs and gaps National research context Resilient, net-zero, circular production systems Biodiversity and climate Sustainable urbanisation Nature & environmentally friendly energy transition Other themes / crosscutting themes	A description of relevant specific national or regional context when it concerns ES R&I Comprehensively reviewed ES R&I needs for the 4 CASRI topics Other or crosscutting RI& needs that were identified
X.2	Promising funding schemes	Promising funding opportunities as seen by the NKS
X.3	Improving the Science Practice Policy interface (SPPI)	Relevant aspects on Science Policy Practice Interaction (SPPI)
X.4	Recommendations for CASRI by NKS	Recommendations and other relevant aspects from the NKS to CASRI
X.5	Reflection on the workflow	Additional information by the NC on the specific workflow and choices that were made during the activities and that influenced the outputs of national reviews

After the individual country reports, overarching/combined appendices are presented, i.e.: appendix A: an overview of relevant national and international networks elated to CASRI themes that the NKS participate in; B: the literature used in the desk studies; C: the questionnaire template used for the interviews; D: the workshop program template; E: the final review results from the International Advisory Board (IAB) and; F: the final review results from the NKS on their country report. The final reviews from the IAB and NKS include recommendations for next phases in CASRI.

PART II: Country reports

This part of the report presents the reviewed, synthesized and prioritized results of the information collated in each of the 14 participating countries and regions (Austria, Basque Country (Spain), Bulgaria, Finland, Flanders (Belgium), France, Germany, Ireland, Italy, Montenegro, The Netherlands, Slovakia, Switzerland, Wales (UK)).

1 AUSTRIA – National Report

Authors: Camilo Molina, Judith Neumann, Kathrin Röderer

Country report specific abbreviations

ACRP	Austrian Climate Research Program
AIT	Austrian Institute of Technology
AWS	Austria Wirtschaftsservice
BMAW	Bundesministerium für Arbeit und Wirtschaft (Austrian Federal Ministry for Labour and Economy)
BMBWF	Bundesministerium für Bildung, Wissenschaft und Forschung (Austrian Federal Ministry for Education, Science, and Research)
BMK	Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology)
BML	Bundesministerium für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft (Austrian Federal Ministry for Agriculture, Forestry, Regions and Water Management)
BOKU	University of Natural Resources and Life Sciences, Vienna (Austria)
CDG	Christian Doppler Forschungsgesellschaft, Austria
CETP	Clean Energy Transition Partnership
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
DUT	Driving Urban Transitions Partnership
EEA	Environment Agency Austria
EFRE	Europäischer Fonds für Regionale Entwicklung (European Regional Development Fund)
Eu-SPRI	European Forum for Studies of Policies for Research and Innovation
FFG	Österreichische Forschungsförderungsgesellschaft mbH (Austrian Research Promotion Agency)

FORWIT	Rat für Forschung, Wissenschaft, Innovation und Technologieentwicklung (Austrian Council for Sciences, Technology, and Innovation)
FTI, RTI, RDI	Research, Technology/ Development, Innovation
FWF	Österreichischer Wissenschaftsfonds (Austrian Science Fund)
FZÖ	Fonds Zukunft Österreich (Austria)
IPCEI	Important Projects of Common European Interest
JPI	Joint Programming Initiative
JTF	Just Transition Fund
KEM	Klima- und Energie-Modellregionen (Climate and Energy Model Regions in Austria)
KLAR!	Klimawandel-Anpassungsmodellregionen (Climate change adaptation model regions in Austria)
KLIEN	Klima- und Energiefonds (Climate and Energy Fund, Austria)
NEFI	New Energy for Industry
ÖAW	Österreichische Akademie der Wissenschaften (Austrian Academy of Sciences)
ÖGUT	Österreichische Gesellschaft für Umwelt und Technik (Austrian Society for Environment and Technology)
ÖROK	Österreichische Raumordnungskonferenz (Austrian Conference on Spatial Planning)
OSA	Open Science Austria
WWTF	Wiener Wissenschafts-, Forschungs- und Technologiefonds (Vienna Science and Technology Fund, Austria)
ZSI	Zentrum für Soziale Innovation (Centre for Social Innovation, Austria)

AUSTRIA - SUMMARY IN GERMAN

KURZFASSUNG DEUTSCH

Der vorliegende Bericht basiert auf Interviews und einem Workshop mit ausgewählten Stakeholder:innen über aktuelle Anforderungen der umwelt- und nachhaltigkeitsbezogenen Forschung und Entwicklung, sowie der Schnittstelle zwischen Wissenschaft, Praxis und Politik. Unser Dank gilt allen beteiligten Personen.

Jenseits der F&E-Investitionen von Unternehmen ist die öffentlich finanzierte umwelt- und nachhaltigkeitsbezogene Forschung und Innovation in Österreich stark durch folgende vier missions- und transformationsorientierten FTI-Schwerpunkte strukturiert: Energiewende, Mobilitätswende, Kreislaufwirtschaft und Klimaneutrale Städte. Synergisch zu diesen Schwerpunkten gestaltet sich die Beteiligung Österreichs an europäischen und internationalen Partnerschaften und Agenden, wie EU-Partnerschaften und –Missionen, dem Europäischen Forschungsraum und den „wichtigen Vorhaben von gemeinsamem europäischen Interesse“ (IPCEI).

Im Rahmen der vier von CASRI festgelegten Themenbereiche haben die Stakeholder:innen folgende Forschungs- und Innovationsprioritäten angeführt:

Resiliente, netto-null, zirkuläre Produktionssysteme: Weiterentwicklung der Lebenszyklusanalyse (LCA); biobasierte Industrie(anwendungen); additive Fertigung.

Biodiversität und Klima: Biodiversität und Naturschutz; Synergien zwischen Klimaschutz und Klimawandelanpassung; wildökologische Raumplanung; Biodiversitätsmainstreaming; Klimawandelanpassung in Land- und Forstwirtschaft; Weiterentwicklung des Managements von Wasserressourcen; soziale und gesundheitliche Auswirkungen des Klimawandels.

Nachhaltige Urbanisierung: Einbeziehung von Biodiversität in die Strategie für klimaneutrale Städte; Senkung der THG-Emissionen im baulichen Bestand; Hitzemanagement in Städten; Anpassungen des öffentlichen Raumes; rechtliche und finanzielle Rahmenbedingungen für die Entwicklung grüner Infrastruktur.

Natur- und umweltverträgliche Energiewende: Wasserstofftechnologie; erneuerbare Gase; Kohlenstoffabscheidung und –speicherung; rechtliche und wirtschaftliche Herausforderungen dezentraler Energiesysteme; (Umwelt-)Bewertung von Energiespeichertechnologien.

Folgende übergreifende Forschungs- und Innovationsthemen wurden von den Stakeholder:innen als wichtig oder dringend erachtet: Mobilitätswende; Verschränkung von Nachhaltigkeits- und Sicherheitsagenden; Umgang mit Nachhaltigkeitszielkonflikten; Skalierung sozial-technischer Innovationen; Modellierung und Monitoring von Multi-System-Transformationen; nachhaltige Digitalisierung; Just Transition; konzeptionelle und rechtliche Rahmungen des Verhältnisses zwischen Mensch und Natur.

Folgende Forschungsbereiche werden nach Ansicht der Stakeholder:innen bisher unzureichend durch bestehende Förderinitiativen abgedeckt: Künstliche Intelligenz und Nachhaltigkeitstransformation; Forschung zu Biodiversität und Naturschutz; die Verflechtung von gesellschaftlichem und ökologischem Wandel; soziale und gesundheitliche Auswirkungen des Klimawandels; Umgang mit Nachhaltigkeitszielkonflikten; konzeptionelle und rechtliche Rahmungen des Verhältnisses zwischen Mensch und Natur.

Ein erheblicher Teil der Mittel für umwelt- und nachhaltigkeitsbezogene Forschung und Innovation wird über Ausschreibung und Förderinstrumente bereitgestellt, die eine Zusammenarbeit verschiedener Institutionen und Organisationen erfordern. Dennoch äußerten Stakeholder:innen den Bedarf nach einer besseren Koordination von umwelt- und nachhaltigkeitsbezogenen F&E-Initiativen, nach systemischem Wissen und nach stärkerem Fokus auf Veränderungsprozesse. Dies erfordert teilweise veränderte Rollen von Akteur:innen, wie kleinen und mittelständischen Unternehmen, der öffentlichen Verwaltung oder von Bürger:innen, in transdisziplinären F&E-Aktivitäten.

Eine strategische Forschungs- und Innovationsagenda (SRIA) unter prominenter Beteiligung der Umweltagenturen in ihrer vermittelnden Rolle zwischen Wissenschaft, Verwaltung und Öffentlichkeit, kann hier einen Unterschied machen. Die Interviews und Diskussionen mit Stakeholdern ergaben u.a. die folgenden Empfehlungen für die CASRI SRIA:

- Ausbau eines **missionsorientierten Ansatzes**, der mit breiteren Zielen und Ansätzen der Europäischen Union in Einklang steht, über den Rahmen der Agenda 2030 hinausgeht und neuere Themen wir Digitalisierung und KI berücksichtigt;
- eine **transformative Perspektive**, die an der aktuellen Rolle von Umweltagenturen bei Entwicklung, Umsetzung, Vollzug und Evaluierung nationaler und europäischer Umweltpolitik ansetzt;
- eine Orientierung auf die Weiterentwicklung von Transformationswissen, u.a. durch die **Integration von sozialwissenschaftlicher und technologischer Forschung**;
- eine Ausrichtung auf den Aufbau und die Unterstützung von **Akteurskonstellationen** als Mittel zur Förderung gesellschaftlichen Engagements, zur Schaffung von Lernräumen und somit zur Generierung jenes Wissens, das für eine Nachhaltigkeitstransformation in den ausgewählten Bereichen notwendig ist;
- Ein Fokus auf die Operationalisierung und **Messung von Nachhaltigkeitstransformation** und auf die Bereitstellung von Daten, um Monitoring zu ermöglichen und Zielbilder, Transformationspfade und aktuelle Entwicklungen abzugleichen.

AUSTRIA - EXECUTIVE SUMMARY ENGLISH

The present report is based on interviews and a workshop with selected stakeholders about environmental and sustainability research and innovation (ES R&I) needs and the SPPI in Austria. We extend our gratitude to all participants.

Beyond the R&D of individual private companies, ES R&I is largely structured along the four mission- and transformation-oriented focal points of the national research, technology and innovation (RTI) policy: climate neutrality in cites and municipalities; energy transition; mobility transition; circular economy and production. These agendas are considered to be synergic with Austria's engagement in European and international R&I agendas, such as EU partnerships and missions, the European Research Area (ERA), and Important Projects of Common European Interest (IPCEI).

Within the CASRI thematic areas, the following R&I priorities were expressed by NKS:

Resilient, net-zero, circular production systems: further development of Life Cycle Assessment (LCA); bio-based industries; additive manufacturing.

Biodiversity and climate: biodiversity and nature conservation; synergies of climate protection and climate change adaptation; wildlife ecological spatial planning; biodiversity mainstreaming; climate change adaption in agriculture and forestry; advanced strategies for water management; social and health impacts of climate change.

Sustainable urbanisation: including biodiversity in climate-neutral cities strategy; lowering GHG emissions in existing housing stocks; heat management in cities; adaption of public spaces; legal and financial innovations in green infrastructure development.

Nature & environmental friendly energy transition: hydrogen technology; renewable gases; carbon removal and capture; sector coupling; legal and economic challenges in energy decentralization; assessment of energy storage technologies.

The following crosscutting R&I themes were expressed by NKS as urgent or important: mobility transition; interlocking of sustainability and security agendas; balancing sustainability conflicts, upscaling of socio-technical innovations; understanding, modelling and monitoring multi-system-

transformation and transitions; sustainable digitalisation; just transition; conceptual and legal framing of the human-nature-relationship.

The following thematic areas were found not to be sufficiently covered by funding in Austria: AI and sustainability transition; biodiversity and nature conservation research; the interconnection of social/societal and ecological transformation, social and health impacts of climate change; balancing sustainability conflicts; conceptual and legal framing of the human-nature-relationship.

A significant portion of ES R&I funds is allocated through calls and instruments requiring collaborative relationships between different institutions and organisations. Still, stakeholders expressed the need for a better coordination of ES R&I initiatives generating more systemic knowledge, and a stronger focus on promoting change. This requires, in part, a redefined role for actors such as small and medium enterprises (SME), the public administration, and citizens, in transdisciplinary ES R&I activities.

A strategic research and innovation agenda (SRIA), with environmental protection agencies (EPAs) in their mediating role between science, administration, and the public at its centre, can make a difference here. The interviews and discussions with Austrian stakeholders yielded the following recommendations for the CASRI SRIA:

- expansion of a **mission-oriented approach** that aligns with the broader goals and strategies of the European Union, extends beyond the Agenda 2030 framework, and incorporates emerging topics such as digitisation and AI;
- a **transformative perspective** that builds on the current role of EPAs in the development, implementation, enforcement, and evaluation of European and national environmental policy;
- an orientation towards the further development of transformative knowledge, including through **integrating social and technological science and R&I**;
- an orientation towards fostering and supporting **actor constellations** as a means to promote societal engagement and generate the necessary learning and knowledge for ES transformation in the selected thematic areas;
- a focus on the operationalisation and **measurement of ES transformation**, alongside the provision of **data** to enable monitoring and compare target visions, transformation pathways, and current developments.

1.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

1.1.1 National research context

Austria's environmental and sustainability research and innovation (ES R&I) strategy reflects a growing investment in R&D, with expenditures rising from 3.06% of GDP in 2017 to 3.34% in 2024. As a "Strong Innovator," Austria ranks in the upper mid-range of European countries. In 2024, Austrian companies will lead R&D investments with 7.4 billion euros (45% of total), followed by the federal government contributing 4.6 billion euros (28%). The research premium for R&D-active companies will add 1 billion euros. Federal states provide 700 million euros, while municipalities, universities, and other public entities contribute 260 million euros. Foreign organizations, mostly international firms, invest over 2.6 billion euros (Ecker et al., 2024).

Austria ranks medium to high in EU environmental indicators: 2nd in environmental protection expenditure, 5th in renewable energy share, 7th in circular material use rate, and 10th in resource productivity. The country also excels in green technology patents, focusing on waste and water management, climate-friendly buildings, and production technologies (Ecker et al., 2023; European Patent Office & European Investment Bank, 2024).

During the last legislative period from 2019 until 2024, Austria merged climate and technology policies under the Federal Ministry for Climate Action (BMK), supporting climate targets and green transformation as outlined in the Federal 2030 RTI strategy and the 3-year RTI pacts, which allocate 5 billion euros for 2024-2026. This sum includes budgets to RTI institutions and programmes in basic and applied research (universities excluded) from the Federal Ministry of Education, Science and Research (BMBWF), the BMK and the Federal Ministry for Labour and Economy (BMAW).

In a broader understanding of its role as the main governmental body responsible for applied research and innovation addressing complex societal challenges, the BMK is adopting a 'transformative innovation policy' approach (OECD, 2024). This implies 1) strengthening systemic understanding, strategic intelligence, target and impact orientation, agility and the ability to learn; 2) a "whole-of-government-approach" combining various levers of the administration (in its different roles as legislator, regulator, investor, R&I funder, procurer, partner); 3) a focus on building and strengthening innovation communities and ecosystems; 4) employing a broad mix of instruments such as innovation labs, public-public partnerships, regulatory sandboxes, large-scale innovative projects (bundling R&I and investment promotion).

The Ministry's remit is thus partly structured along four mission- and transformation-oriented RTI focal points: 1) climate neutrality in cities and municipalities; 2) energy transition; 3) mobility transition; 4) circular economy and production. These national priorities are perceived to be highly synergic with European and international R&I agendas: Horizon Europe, EU partnerships and missions, the European Research Area (ERA), Important Projects of Common European Interest (IPCEI), OECD research and technology agendas.

The BMK funds open-topic research through the Austrian Research Promotion Agency (FFG) with 190 million euros annually (2024-2026). An equal amount supports the 4 RTI focal points, as well as key technologies. The "Climate and Transformation Offensive," managed by BMK and BMAW, allocates 5.7 billion euros for sustainability-related R&D until 2030. The Climate and Energy Fund (KLIEN) receives around 60 million euros annually from BMK and EU sources for aligned programs.

Austria's EPA, the Environment Agency Austria (Umweltbundesamt, EEA) is formally a limited liability company owned by the Federal State. It performs official duties in the areas of environmental monitoring and reporting, while also providing consultancy services – primarily on behalf of the BMK, but also for other governmental and private clients. The EEA thus plays a role as both a knowledge user and a knowledge provider in the areas of climate, circular economy, biodiversity, and zero pollution. In this capacity, it is also involved in research projects and partnerships.

1.1.2 Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
There is a need for the standardisation or harmonisation of Life Cycle Assessment (LCA) to obtain more regionally and temporally comparable data on the environmental impacts of economic activities, consumption patterns, and lifestyles.	S	Short term: better awareness of sustainable and unsustainable practices; more accurate measures towards a circular economy taking into account the needs and impacts of private consumption.	N, E, I
Bio-based industries: crucial for transitioning to a sustainable economy by reducing reliance on fossil fuels and lowering carbon emissions	S	Short and long term: significantly reduce carbon emissions and reliance on fossil fuels, driving innovation in sustainable materials and energy.	I
Additive manufacturing is revolutionizing production by allowing for the creation of complex, customized products with minimal waste.	A	Short term: transform manufacturing processes, leading to more sustainable production, cost savings, and greater product customization.	I

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

1.1.3 Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Research gaps in conservation must be addressed, e.g. pollinators' role in ecosystem health and agricultural productivity	A	Short term: understand the target conflicts of biodiversity and climate	N
Identify synergies between climate protection and climate change adaption	S	Short term: understand how climate protection and adaptation efforts can complement each other	R, N, E, I
Promote biodiversity via “wildlife ecological spatial planning”, connecting biodiversity-rich areas and involving landowners	A, T	Long term: Expand natural landscapes to promote biodiversity and reduce reliance on harmful pesticides; enable climate change adaption of ecosystems through habitat connectivity and wildlife corridors	R, N

Mainstreaming biodiversity into energy, finance, and infrastructure to minimize ecosystem impacts and secure long-term stability and ecosystem services.	S	Long term: secure ecosystem services and promote sustainable growth and social stability	I
Climate change adaptation in agriculture & forestry: holistic approaches in plant breeding & management systems (climate-resilient forests, adaptation of cultivated plants, disease resistance)	S, A	Long term: resilience of agriculture and forestry, reduction of pesticide use, biodiversity protection	N, E, I
Developing advanced strategies for water management, focusing on glacier preservation, efficient water use, and ensuring that technical systems are adapted to future water needs.	S, A, T	Long term: secure water resources in the face of climate change; ensure resilient infrastructure for sustainable resource management	N
Social and health impacts of climate change	S	Long term: better shaping of climate protection and adaption policies	N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

1.1.4 Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Include biodiversity in Austrian climate-neutral cities strategy (as in EU Green City Accord)	A, T	Short-term: Synergies between climate change adaptation and climate protection as well as focus on biodiversity	N
Supply existing housing stock with sustainable energy and reduce demolition & construction as a means of lowering GHG emissions and resource use. Development of new water usage systems	A, T	Long term: Contribution of resource minimisation in cities to support goal of climate neutrality by 2040	R, N, E, I
Increasing green spaces, enhancing shading and adopting innovative building designs to promote cooler and more liveable cities. Creating fresh air corridors and improving airflow to reduce heat islands and improve public health.	S, A	Making urban environments more resilient and sustainable. Short term	R
Multifunctional use of public areas, e.g. parking spaces.	A	Long-term: Climate adaption and resilience	R

Legal and financial innovations supporting proactive infrastructure development, e.g. long-term financing models allowing for energy storage systems and grid reinforcements to be pre-built, in anticipation of future use. This is particularly relevant in urban settings, where opportunities arise to integrate new components (like geothermal probes) during routine construction projects such as roadworks.	A, T	Short-term: Enhance readiness, but also optimize cost-efficiency of urban sustainability transformation	R, N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

1.1.5 Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Hydrogen technology, renewable gases, carbon removal, and carbon capture utilisation storage technologies incl. production processes and materials to replace fossil fuel use and lower GHG	S	Long term: Efficient and more sustainable energy generation	N, E, I
System design and operation of flexible, integrated energy systems, including sector coupling (integrating renewable energy with other sectors such as heating, mobility, and chemicals)	S	Long term: resilient renewable energy storage and supply	N, E, I
Address legal and economic challenges posed by decentralization and flexibilization of energy supply (digitalization, data availability requirements vs. data protection, new storage solutions, ...)	A, T	Short term: Creating a legal and economic framework supporting emerging provision and business models in the energy transition	N, E
Development and assessment of energy storage technologies (batteries) in terms of functionality (for different timeframes) and resource consumption (kind of raw material requirements)	S, A	Short term: environmentally friendly energy transition	R, N, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

1.1.6 Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Impact of crises and geopolitical shifts: Assess how concerns of resource supply security, technological sovereignty, and institutional resilience influence ES agendas and transformation pathways	*S, T*	Short term: Systemic knowledge for adapting ES policy, interlocking of sustainability and security agendas	R, N, E, I
How to move from experimentation with socio-technical innovations to their generalisation (replication, transfer of learnings and know-how); how to upscale research findings - which kind of competencies and governance innovations are needed	A, T	Short term: Acceleration of innovation and change, better role of different levels of the public administration as intermediaries	R, N
Interaction of different forms of innovation (technical, institutional, social) in specific transformations (e.g., the de/centralization of energy supply); transdisciplinary research on socio-economic and ecological transformation	S, A	Short term and long term: better understanding of sustainability transformation; more effective ES policy (e.g., by addressing rebound effects, avoiding 'regrettable substitutions')	R, N, E, I
Better modelling of multi-system-transformation (e.g. energy, industry and mobility) is needed; existing models tend to be focused on single subsystems, with oversimplified assumptions about neighbouring subsystems	S, A	Short term: better understanding of sustainability transformation	N, E, I
A closer look at 'intermediaries' in the governance of transformation processes (such as public procurement, energy and innovation agencies, service providers, types of civil society, user groups); analyse processes of inter- and intra-organisational change.	S, T	Short term: better understanding of sustainability transformation, supporting processes of change, advancing towards ES goals	R, N

Advance data hubs, and AI for efficiency, sustainability, and environmental monitoring (incl. indicators for transformation); as well as standards for sustainable digitalisation. Empirical evaluation of projects, funding, and policies require comprehensive and widely accessible data	A	Short term: Support “Climate Neutrality 2040” through digitalization, boosting efficiency, sustainability, and environmental protection	N, I
Mobility transition: Ensures quality of life and economic resilience in an evolving ecological and economic context. Enhances competitiveness, employment, and international demand for Austrian innovations (regional solutions, infrastructure, policies)	A, T	Short term: not only for CO2 reduction, but also to ensure quality of life	R, N, E, I
A better conceptualization and operationalisation of inclusive forms of transition, particularly of ‘just transition’ to a climate-neutral economy, reducing emissions in key sectors (coal, steel, cement, oil, gas, etc.), local needs, participation, e.g. energy communities, new business models, socio-economic enterprises, social governance (EU action plan)	S, A, T	Short term: better orientation of ES policy (in Austria just transition revolves more around ‘labour market/qualification’; it should actually be understood as empowerment for the transition to a climate-neutral economy); long term: “Climate neutrality 2040” as a national goal	R, N, E, I
Balancing sustainability conflicts: There is a need to research and address the inherent conflicts within sustainability goals, such as biodiversity versus energy transition or economic growth versus circular economy	S	Short term: better orientation of ES targets and policies	N, E, I
A further development of the conceptual framing and legal framework for a new relationship between humans and nature (e.g. legal status of natural objects)	S	Short term: operationalisation and framing of sustainability pathways	E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

1.2 Promising funding schemes

A significant portion of ES R&I related public funding (structured along the "transformative focal points", see section 1.1.) is allocated through calls and funding instruments provided by the Austrian Research Promotion Agency (FFG), which require collaborative relationships between research institutions and private organisations, companies and platforms. These instruments also serve in the implementation of international programmes.

The following general reflections on current funding schemes were made by national key stakeholders, hinting to persisting gaps in ES R&I funding:

- There still is a need for improved integration of environmental and sustainability-related topics and a better breaking down of silos for funding schemes to be attractive for practitioners – the goals of "knowledge users" frequently do not fit in with the thematic focus of funding programmes. The separation of climate mitigation and climate adaption in the LIFE programme was mentioned as an example (the connection and synergies of the two being pursued by practitioners). Equally, a systemic perspective on electro mobility needs to transcend the traditional boundaries of the energy and mobility sectors.
- Funding budgets are heavily oriented towards innovations but often lack the resources to support the implementation of these innovations (e.g., regulatory approval processes, participatory engagement with local communities), which can be very time-consuming and resource-intensive. While innovation-related additional costs might be funded, the necessary baseline costs to achieve these innovations are often not covered.
- In certain thematic areas, there still is a need for limited ES R&I funding for Small and Medium Enterprises (SME). This is particularly the case in agriculture, where most enterprises lack the financial capacity to conduct wide-scale R&D (even in co-financed FFG projects) on climate and biodiversity-related topics. An uncomplicated funding scheme providing small partnerships between farmers and research organisations with the opportunity to cover laboratory and other costs for application-oriented R&I could help.
- As for current EU R&I funding, interview partners criticised that it should be less of a supplement to regional or national R&I funding, and more focused on priorities and goals that can only be achieved through transnational cooperation.
- There is a lack of transnational cooperative basic research funding at the European level. European basic research is structured by individual research grants and fellowships. In recent years, EU research funding has increasingly shifted towards higher Technology Readiness Levels (TRL), i.e. more focus on application and implementation. Research funding should better enable interaction between basic and applied research (for example, by allowing results and questions form applied research to provide new impulses in basic research).
- On the other hand, some stakeholders argue that EU research agendas need to prioritize outcomes and societal impact, rather than managing resource allocation. Aligning resources more closely with measurable results is essential to enhance the effectiveness of funding schemes, with the measurement of impact itself being an important R&I topic.

The following thematic areas are currently considered not to be covered sufficiently by funding:

- Developing important applications of AI and data sectors in areas relevant to sustainability transition
- Biodiversity and nature conservation research, incl. agroforestry
- Transformation research and research on societal transformation (see related crosscutting themes in section 1.1.6.)
- Social and health impacts of climate change

- Balancing sustainability conflicts: There is a need to research and address the inherent conflicts within sustainability goals, such as biodiversity versus energy transition or economic growth versus circular economy
- Further development of the conceptual framing / legal framework for a new relationship between humans and nature (e.g. legal status of natural objects)

No more specific discussions with NKS have been held regarding the most suitable funding schemes for CASRI, as narrowing down its goals, thematic focus and involved stakeholders would be a prerequisite for this. This also concerns the main justifications essential to persuade specific national funders to join CASRI as a cross-national funding initiative.

1.3 Improving the Science Practice Policy interface (SPPI)

The SPPI in Austria is predominantly conceived as collaboration between scientists and policymakers, with some engagement of scientists in public debates and some collaborations with businesses (primarily large corporations supported by targeted funding schemes; SMEs remain underrepresented). Key initiatives include the Climate Change Centre Austria (CCCA), which synthesizes research results and manages expert communities, and the Climate Citizens' Council, integrating public input into policy recommendations for climate neutrality by 2040. Austrian universities also contribute at the European level through networks like the Science Advice for Policy by European Academies (SAPEA).

However, several challenges hinder the SPPI's effectiveness:

- Stakeholders highlight the need to balance bold, transformative ideas with detail-oriented approaches to drive impactful change.
- Coordination to create aligned SRIAs and roadmaps is strong in tech sectors but lacking in ES R&I, where there is a need for better impact orientation and stakeholder integration.
- At the project level, effective collaboration during a project may not continue after its completion, complicating the transfer of knowledge into practical applications and reducing long-term impact of the research.
- A shift from a traditional, linear research progression (from basic research to a new product) to integrated, system-focused approaches, backed by political commitment, is urgent in areas like rapid industrial decarbonization.
- The separation between social and technological R&I must be bridged.
- The challenge is also about rethinking organisational and administrative structures for researchers, practitioners and citizens to collaborate in research as well as in the implementation of innovations. This should help fostering engagement and trust, as well as translating complex scientific findings into actionable policies and practical guidelines for stakeholders.

Opportunities for improvement include:

- Developing mission-oriented RTI policies that align research efforts with societal goals and creating independent platforms for credible, rapid dissemination of findings.
- Credibility can be achieved by transparently evaluating impacts of interventions and policies.
- The SPPI may be improved by better coordination of ongoing projects, where results are consolidated and fed back to relevant stakeholders.

- New models for the SPPI should be developed participatorily, involving a wide range of target groups to ensure that the concerns of all stakeholders are fully integrated into the design and implementations.
- Collaborative projects should aim to provide momentum for learning processes in public administration and contribute to integrate systemic thinking and context competence into key organisations.
- Building skills within public administration to translate research into policy, using clear and accessible research outputs, and seconding researchers into public roles can strengthen the SPPI.
- Joint training programs for early-career researchers and policymakers can facilitate systematic collaboration.

CASRI could incorporate some of these opportunities for improving the SPPI and/or take them into account in developing its SRIA.

1.4 Recommendations for CASRI by NKS

The stakeholders recommend considering the following aspects in the development of the CASRI SRIA and cross-national funding mechanisms:

Alignment with EU Strategies: The SRIA should be strategically aligned with broader EU policies and orientations, extending beyond the Agenda 2030 framework. Crosscutting themes, such as digitization and AI, should be integrated in a coordinated manner, as in the EU's mission-oriented approach, to identify interdependencies and develop comprehensive solutions for societal challenges.

A transformative perspective: A crucial strategic question for environmental agencies is how to develop improved implementation processes and move beyond just "counting, weighing, measuring". The role of EPAs in current European and national environmental policy implementation and enforcement should be to become the starting point for defining R&I needs and developing a common SRIA.

A shared understanding of actor constellations: The SRIA should be based on a shared understanding of the actor constellations required for sustainability transformation and the role of EPAs within this context. It should focus primarily on supporting transformative collaboration constellations where scientists and environmental experts from EPAs and partner institutions can contribute their knowledge in a practice-relevant manner.

Promote societal engagement: Scientific scepticism and the question of how to engage society in sustainable development should be considered as central practical challenges in the development of an innovation agenda. Many stakeholders emphasize that successful sustainability transformation critically depends on meaningful societal participation. This includes involving local communities, businesses, and civil society in decision-making processes to ensure that initiatives are grounded in the needs and values of the population, thereby enhancing both effectiveness and public acceptance. Develop a system-oriented approach and a SRIA that is orientated towards the participatory involvement of stakeholders in ES transformation and innovation projects.

Integrate social and behavioural science: ES R&I must integrate social and behavioural sciences to offer a nuanced understanding of societal challenges. This includes considering both top-down (policy-driven) and bottom-up (community-driven) perspectives. It is essential to address societal friction points and remain receptive of unexpected outcomes.

Measure and evaluate transformation: The SRIA could focus on operationalizing and monitoring target visions of the sustainability transformation and advancing the provision of data and standards in this regard. It should itself be evaluated and reflected upon in terms of societal transformation.

1.5 Reflection on the workflow

The stakeholders included in the information collection process came from diverse sectors and pursued different agendas. In terms of representativeness, the inclusion of more stakeholders from the business community and from more different levels of public administration could have strengthened the sample. We chose to invite a representative from the industrial association and two smaller research institutes that work independently, but no representatives of individual large business, to avoid selectivity biases. As for practitioners in public administration, due to the quantitative limitations of the stakeholder sampling, we primarily selected officials in federal administration and national organisations. Practitioners from cities were also included due to their relevance to the CASRI theme “sustainable urbanisation”. The perspective of federal states, which can be relevant in Austria, could not be adequately taken into account.

The stakeholder workshop was structured by the following circumstances and considerations: Given the uncertainty in the engagement level of most stakeholders, the aim was to ensure maximum participation in the workshop through a condensed duration and an engaging format. Since the reduced number of 11 NKS participating in the workshop (compared to the 22 interviews) only partially reflect the expertise across the four CASRI themes that emerged from the interviews, the focus was placed on cross-cutting issues and on positioning a CASRI SRIA within the SPPI. The three thematic complexes chosen for in-depth discussion in sub-groups reflected the intersections in the expertise and interests of the participants from whom the highest likelihood of attendance was anticipated.

The information collection and selection steps leading up to this report were the following:

- Desk research on ES R&I policy, agendas, programmes and organisations in Austria. This served as a basis for the interviews with stakeholders and informs the section 1.1 (national research context), as well as the state of the art tables on R&I agendas/programmes and funding schemes (not included in this report).
- The contents of the interviews were incorporated into an interim draft report, which was reviewed by the WP lead. This formed the basis for the entries in sections 1.2.-1-6 and for the information in chapters 2, 3, and 4.
- For this version of the report, recommendations of the WP lead following the submission of the interim draft report were followed. Content that was not sufficiently specified in relation to the scope of CASRI was removed; some points were summarised or elaborated upon more effectively. The discussion in the stakeholder workshop also allowed for the addition or specification of certain topics, such as digitalisation and AI, participation, and transformative ES R&I. Topics in section 1.1.6. that were prioritized or elaborated upon by several stakeholders during the workshop are highlighted in bold. The workshop discussion was also taken into account in the revision of chapter 3 and 4, leading to condensation but also further specification of individual points.

As it was necessary to pick out certain topics due to the time constraints of the workshop, information collected during the desk research and the interviews was richer than the workshop results.

However, the working group and plenary discussions added a new level of information and resulted in a shared understanding of most relevant R&I gaps and needs and possible improvements of the SPPI. Although it was not possible to validate all topics raised in the interviews, workshop results brought a deeper understanding and a unified perspective. The three-hour timeframe, though limited, was sufficient to generate these insights while ensuring broad stakeholder participation.

2 BASQUE COUNTRY – National/Regional Report

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Country report specific abbreviations

BERC	Basque Excellence Research Centers
BRTA	Basque Research & Technology Alliance
DNSH	Do No Significant Harm
K4P[3]	Knowledge for Policy
LULUCF	Land Use, Land-Use Change and Forestry
PCTI	Basque Science and Technology Plan
PMA	Basque Environmental Framework Program
RVCTI	Basque Network on Science and Technology
S4P[4]	Science for Policy

SUMMARY IN BASQUE

Euskal Autonomia Erkidegoa eskualde txikia da, dentsitate handikoa, industrializazio-maila handikoa, gobernantza kapilar eta aurreratukoa, autogobernukoa eta autonomia fiskalekoa, egonkortasun politikokoa, iraunkortasunaren aldeko apustukoa eta kohesio soziokultural, enpresarial eta zientifiko-teknologiko handikoa. Horregatik, azken batean, «ingurumen-trantsizioko politiken eskualde-laborategia» da, zeinak erabaki egokiak har baititzake I+G+b arloko mekanismo berriak, jardunbide onenetan oinarritutako benchmarking xehatuak, azkar esperimentatu ondoren (adibidez, CASRI).

Ingurumen-plangintzak (Environmental Framework Programme PMArekin eta klimaren eta ingurumenaren arloko azpiprograma ugarirekin) eta I+G+b´ko plangintzak (PCTIrekin) bi hamarkada baino gehiagoko ibilbide luzea eta heldutasun handia dute. Plangintza energetiko-klimatikoa-ingurumenekoak eta lurralde-plangintzak, ingurumen-trantsizio integral batek hobetzeko ibilbidea du oraindik, eta arrakalak daude, bai epe luzera gauzatzeko moduan, bai hura modu egonkorrean

[3] As K4P we understand the knowledge-based criteria and information that facilitate political decisions to be taken. This means that you are filling the knowledge that you need to activate a policy mix with specific instruments (economic, market, regulatory, voluntary ones…). It´s generally also very close on data, to know the baseline, scenarios, monitoring of cost-effectiveness… Applied research: usually more developed by specialized Institutes or high level consultants. For example, how to we limit best from policy the impact on biodiversity of renewables? What instruments to be used, and where are the threshold for it? What synergies and cross effects can happen with other drivers? Can we simulate them in advance?

[4] We understand S4P on a fundamental level of knowledge, prior to policy decisions (closer to universities). This means low TRLs that gives an integral vision of a challenge or problem (generally close to the DSPIR model of the EEA). Example: When decades ago the Ozone Hole was discovered and the related risks analyzed, or more recently the PFAS impact is being studied.

finantzatzeko moduan, horri aurre egin ahal izateko. Trantsizio berderako ezinbestekoak diren hainbat agentzia publiko egoteak (Ihobe-ingurumena, Eve-energia, Ura-ura, Hazi-basoko nekazaritza, Spri – negozioak, Brta – I+G+b...) eta horietako lehenak ingurumen-politikaren zikloaren dinamizazio integrala egiten duen funtzioak, SPPIren esparruan esperimentazio desberdinek arrakasta izateko eta Euskadiko trantsizio berdeari heltzeko aukerak areagotzen baitituzte.

Lau CASRI eremu I+G+b beharren artean "resilient, net-zero, circular production systems" eta "nature & environmentally friendly energy transition" eremuei emandako bultzada teknologiko argia erakusten du; izan ere, 8 premia mapatu arren, ez du behar bezala garatzen SPPI, erreaktibo gisa bideratzen baita batez ere enpresa-eskaeretara. CASRIri begira, lehentasunik nabarmenenak “Smart Economic Environmental Flows Data System” delakoa da, adimen artifizialaren laguntzarekin, ingurumen-politikako erabaki onenak hartzeko. Bigarrenik, trantsizio energetikorako inbertsio handien (hidrogeno berdea, berriztagarriak) ingurumen-iraunkortasuna (LCA, biodibertsitatea), ekonomikoa (LCC) eta soziala ziurtatzea.

"Biodiversity and climate" delakoaren eremuan, R & I-ren (17) premia kopuru handiena mapeatu da; izan ere, SPPI bereziki garatuta dago klima-egokitzapenaren esparruan, Euskadik EU Adaptation Mission-en alde egindako apustuari esker. Apustu hori funts propioekin eta transferigarritasun handiko erronketarako irtenbideak frogatzera bideratutako Europako proiektu handiekin hedatzen da. Gaur egun, erronkarik nabarmenena da datuetan oinarritutako eredu integralak eta irizpideak ezartzea (€, ingurumena, soziala), frogatu beharreko irtenbide alternatiboen balidazioa ziurtatzeko eta, ondoren, antzeko kasuistiketara transferitzeko. Ingurumen-trantsiziorako garrantzitsutzat jotzen da, halaber, klima-erresilientziaren eta lurzorua babesteko irizpideen integrazioa, zientzian oinarrituta, funtsezko lurralde-tresnetan (IEA, Lurralde Plangintzaren Gidalerroak...), bai eta lurzoruaren kalitatea monitorizatzeko kostu-sistema eraginkor baten diseinua eta garapena ere.

"Sustainable urbanization" delakoaren eremuan, 7 premia mapatu dira, nahiz eta I+G+b ko talde espezifikoak egon eta EU Mission Cities programan parte hartu, trantsizio berderako ezagutza-arrakala handiak daude oraindik. Beharrik garrantzitsuena Hiria Berroneratzeko irizpide integralak (€, ingurumena, Soziala) garatzea da, epe luzeko erabaki jasangarrietarako, datu ekoonikoetan, ingurumenekoetan eta sozialetan oinarrituta. Hori, aldi berean, dagozkien deliberazio-prozesuetan esperimentatzeari lotuta dago, beste eremu batzuei ere eragiten dien zeharkako lehentasun bat, hain zuzen ere. Azkenik, zeharkako eremuan garrantzia hartzen dute “One Health” delako programaren alderdi integralek eta herritarren inplikazioak (kontsumitzaile gisa eta zientziaren beraren garapenean).

I+G+b teknologikoa "koipeztatuta" dago Euskal Autonomia Erkidegoan, funts propio garrantzitsuekin eta Europako proiektuetan parte-hartze handiarekin. S4P eta K4Prako I+G+b-rako, bi finantzaketa-iturri erabiltzen dira, hau da, agentzia publikoen berezko ildoak (Ihobe, Eve, Hazi...), lizitazio publikoetan oinarrituak, bai eta Europako proiektuak ere (Horizon EU eta Life), batzuetan premia garrantzitsuenetara egokitzen ez direnak.

Ezinbestekoa da SPPIrako lehendik dauden funtsak antolatzea, koherentzia ematea eta ikusaraztea, gutxienez tematikoki, eta, ondoren, aurrekontu propioekin (Cohesion Funds EBko mugatuak edo EBko beste iturri batzuk barne) horretara bideratutako finantzaketa indartzea, ahal dela, aurretiko esperientzia pilotua hobetuko duen programa espezifiko baten bidez (Klimatek).

Kostu-eraginkortasun handikotzat jotzen da, halaber, Europa mailan premia komunetan lan egiteko aukera zabaltzea, CASRI ekimenaren ondoriozko mekanismoen bitartez.

Nabarmendu behar da, halaber, zaila dela proiektu erakusleak egiteko funtsak eskuratzea (adibidez, klima-egokitzapenean eta lurzoruaren babesean), benetako konponbideak frogatu eta optimizatuko dituztenak, modu masiboan transferitzeko eta trantsizioak benetan hedatzeko. Nahiz eta ingurumen-agentzien artean epe luzerako lankidetzarako konfiantza sortzen duten bide arin eta errazak egon, egokia dirudi zehatzago aztertzea funts publiko edo publiko-pribatu bat sortzeko aukera, EBren abalarekin, I+G+b -ren lehentasun komunak finantzatzeko.

“Science Practice Policy Interface (SPPI)” delako hobetzeari dagokionez, aurrerapen eta hobekuntza gutxi egituratuak egin dira. Gomendagarria dirudi Euskadin berriki sortu diren gaikako mekanismoak zabaltzea (adibidez, Lurzorua Babesteko Batzorde Teknikoa, Klima Aldaketaren Batzorde Zientifikoa...), S4P eta K4Pren lehentasunak adosteko. Lehentasun horien sozializazioa ere jarduera garrantzitsua da. Lehentasun horiek eta haien sinergiak, oro har tematikoak, koordinatzeko aukera aztertu behar da, SPPIko Eskualde Kontseiluan SRIA batekin, S4P eta K4Pra bideratua. Gainera, beharrezkoa da zientziaren eta politikaren arteko elkarrizketa adimentsu eta egonkorra indartzea, eta, horretarako, European Environment Agency eta bere NEPA Sareak laguntzeko funtsezko eginkizuna bete dezakete, prozesu hori bizkortzeko material eta dinamika egokiak hornitzea proposatuz.

EXECUTIVE SUMMARY ENGLISH

The Basque Country is a small, high-density region with a high degree of industrialization, capillary and advanced governance, self-government and fiscal autonomy, political stability, a commitment to sustainability and a high degree of socio-cultural, business and scientific-technological cohesion. It is therefore in reality a ‘regional laboratory for environmental transition policies’, which can make the right decisions after agile experimentation with new R&I mechanisms based on adapting best practices or detailed benchmarking (e.g. CASRI).

Both environmental planning with its Environmental Framework Program PMA and multiple climate-environmental sub-programs and RDI planning with its Basque Science and Technology Plan (PCTI) are more than two decades old and highly mature. While energy-climate and spatial planning are the most long-term, a comprehensive environmental transition still has room for improvement, and there are gaps both in how to implement it in the long term and in how to finance it in a stable way in order to be able to tackle it. The existence of several public agencies that are essential for a green transition (Ihobe is responsible for environment, Eve for energy, Ura for water, Hazi for agro-forestry, Spri for business, Brta for R&I, etc...) and the function of the former as an integral dynamization of the environmental policy cycle increases the chances of success of different experiments in the field of SPPI and the approach to the green transition in the Basque Country.

The comprehensively reviewed ES R&I needs for the 4 CASRI themes shows a clear technological focus on ‘resilient, net-zero, circular production systems’ and ‘nature & environmentally friendly energy transition’, which, despite mapping 8 needs, does not sufficiently develop the SPPI by focusing reactively mainly on business demands. The most important priorities for CASRI are, firstly, the Smart Economic Environmental Flows Data System in order to make optimal environmental policy decisions based on IA. Secondly, ensuring the environmental (LCA, biodiversity), economic

(LCC) and social sustainability of major investments in the energy transition (green hydrogen, renewables).
The largest number of R&I needs have been mapped in 'biodiversity and climate' (17), as the SPPI is particularly developed in the field of climate adaptation thanks to the Basque Country's commitment to the EU Adaptation Mission, which is deployed with its own funds and large European projects aimed at demonstrating solutions to highly transferable challenges. Currently, the most important challenge is the establishment of comprehensive models and criteria based on data (Euro, MA, Social) to ensure the validation of alternative solutions to be demonstrated and subsequently transferred to similar cases. The integration of science-based climate resilience and soil protection criteria into key territorial instruments (EIA, Spatial Planning Guidelines,...) as well as the design and development of a cost-effective soil quality monitoring system are also considered of great relevance for the environmental transition.
In 'sustainable urbanization', with 7 mapped needs, despite the existence of specific R&D&I groups and a participation in the EU Mission Cities, there are still important knowledge gaps for a green transition. The most relevant need is the development of integrated criteria (Economic, Environment, Social) of Urban Regeneration for long-term sustainable decisions based on eco-economic, environmental and social data, which in turn is linked to experimenting in the corresponding deliberative processes, a cross-cutting priority that also affects other areas. Finally, in the cross-cutting area, the integral aspects of One Health gain relevance together with the involvement of citizens (as consumers and in the development of science itself).

Technological R&D&I is well 'greased' in the Basque Country, with significant own funds and a high level of participation in European projects. For RDI for S4P and K4P, two sources of funding are used, i.e. the public agencies' own lines (Ihobe, Eve, Hazi, etc.) based on public tenders and European projects (Horizon EU and Life) which, on occasions, do not meet the most relevant needs.

It is essential to organize, give coherence and visibility, at least thematically, to the already existing funds for SPPI in order to then reinforce with own budgets (incl. the limited EU Cohesion Funds or other EU sources) the funding earmarked for it, preferably with a specific program that improves the previous pilot experience (Basque Klimatek Program). It is also considered most cost-effective to deploy the opportunity to work on common needs at European level through the mechanisms resulting from the CASRI initiative. The difficulty of accessing funds for demonstration projects (e.g. in climate adaptation and soil protection) that demonstrate and optimize real solutions in order to massively transfer them for actual deployment of transitions should also be highlighted. While there are simple and agile ways to build trust and confidence for long-term collaboration between environmental agencies, it seems appropriate to explore in more detail the possibility of generating an EU-backed public or public-private fund to finance common R&I priorities.

Regarding the improvement of the Science Practice Policy Interface (SPPI), progress and improvements have been made in a less structured way. It does seem advisable to expand recently created Basque Country mechanisms of a thematic nature (e.g. the Technical Commission on Soil Protection, the Scientific Commission on Climate Change, etc.), in order to reach a consensus on priorities in S4P and K4P. The socialization of these priorities is also a relevant activity. The opportunity to coordinate these priorities and their synergies, usually thematic, in a Regional SPPI Council with a SRIA focused on S4P and K4P should be considered. In addition, strengthening the intelligent and stable conversation between science and policy is necessary, for which the European

Environment Agency and its NEPAs Network can play a key supporting role, and it is proposed to provide the appropriate material and dynamics to accelerate this process.

2.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

2.1.1. National research context

Basque Environmental Planning has been rigorously monitored for 25 years, based on the benchmarking carried out with the Dutch Government, adapting the methodology of its Environmental Framework Program to the Basque reality. The Basque Country includes as a priority the following Plans with objectives that affect the R&I Agenda:

- Environmental Framework Program 2030, (PMA), with its 8 transformative innovative projects to be developed. This Program has worked with 70 economic, social and academic agents to define the object and challenges to be tackled in these projects.
- Energy Transformation and Climate Change Strategy 2030, which derives from the new Law 1/2024 of the same name and its different programs (decarbonization, adaptation, etc.).
- Circular Economy Strategy 2030 including its four-year plans and the Waste Prevention Plan
- Soil Protection Strategy 2030
- Urban Agenda Bultzatu 2030
- Spatial Planning Guidelines, together with the Partial and Territorial Plans.

The preparation of these plans involves the participation of most of the active agents in the Basque Country, with the proactivity of the different public agencies of the Basque Government in the fields of energy (Eve), water (Ura), housing (Visesa), agro-forestry (Hazi), business (Spri), R&I (BRTA) and the environment (Ihobe) being particularly noteworthy. Apart from these, there are smaller plans of institutional importance, such as the Biodiversity Strategy, the Air Quality Plan and other programs (Ihobe) being particularly noteworthy.

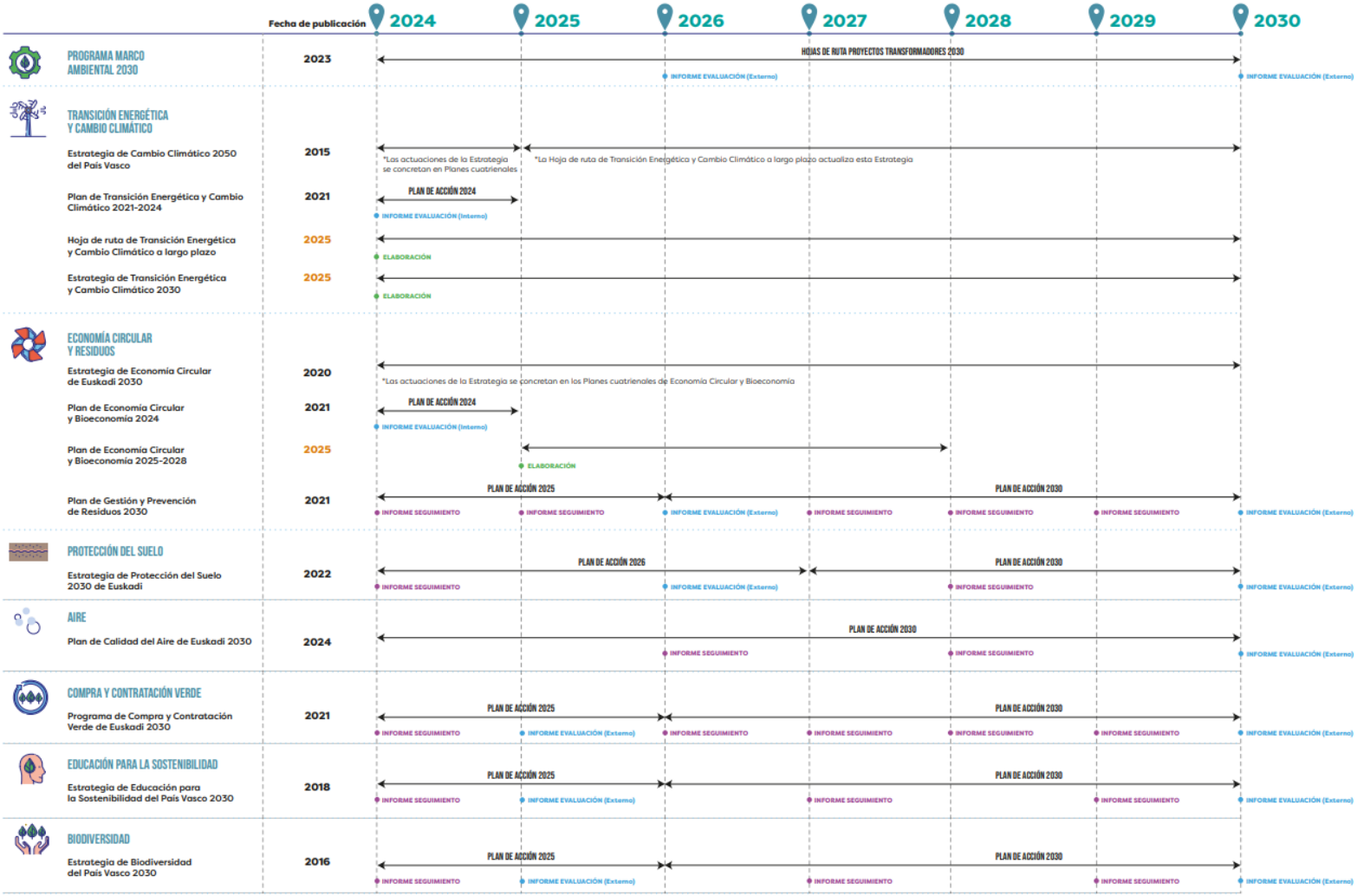

FIGURE 2-1: SUMMARY OF ENVIRONMENTAL PLANNING IN FORCE IN THE BASQUE COUNTRY (UP TO 2030) WITHOUT INCLUDING THOSE THAT HAVE A DECISIVE INFLUENCE ON THE ENVIRONMENT BUT ARE CARRIED OUT IN OTHER AREAS (SPATIAL AND URBAN PLANNING, EMERGENCIES, ETC.)

There are other relevant plans that have a direct impact on environmental objectives, such as the Civil Protection Plan, etc., which have not been included in this reflection.

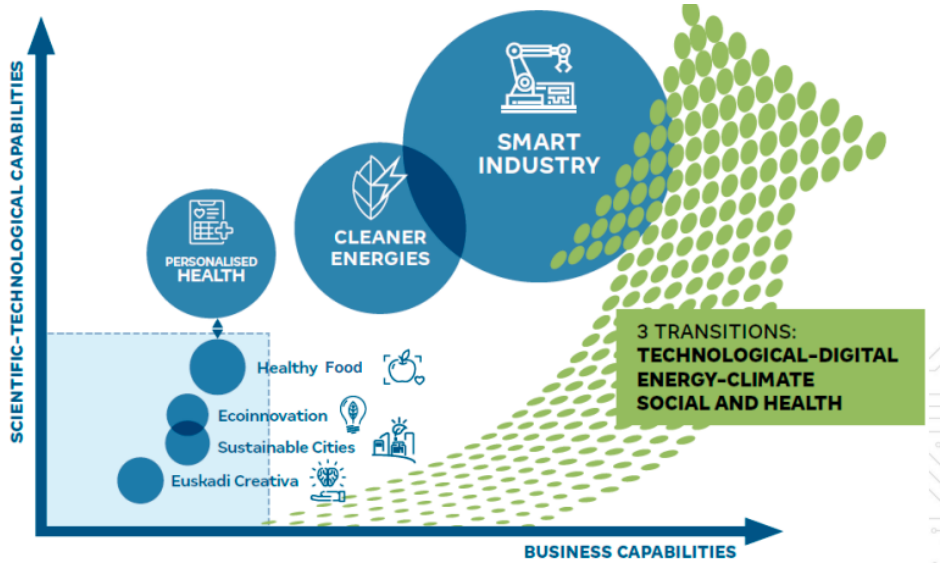

FIGURE 2-2: THEMATIC PRIORITIES, NICHE OPPORTUNITIES (SMALL BALLS) AND TRANSITIONS PILOTED BY THE PCTI 2030

The Science, Technology and Innovation Plan (PCTI) 2030 aims to contribute to three transitions: energy-climate, social-health and technological-digital. Its three priority areas, which receive most of the funds and have a well-defined roadmap, are smart industry, clean energy, personalized health and 4 smaller niche opportunities (eco-innovation, healthy food, creative country and sustainable cities). In addition, there is a limited Innovation Fund that promotes synergies between the different areas. The PCTI has been located in the Department of the Presidency of the Basque Government due to its cross-cutting nature. However, in September 2024 its coordination has passed to the new Department of Science, Universities and Innovation, although most of the funds are still in the Department of Industry, Energy Transition and Sustainability.

It should be noted that, within the framework of the PCTI, the 'Strategy for the internationalisation of Basque R&D&I' is included, which is supported by an observatory mainly focused on Horizon EU and Life projects with Basque participation.

The science infrastructure is coordinated by the Basque Science and Technology Network (RVCTI), which includes 139 members such as Universities, Centres of Excellence, Technology Foundations and Institutes and Business R&D&I Units from all fields. In addition, the creation of the 9 Basque Excellence Research Centres (BERC) for basic research and the Basque Research & Technology Alliance (BRTA) for applied research with 17 R&D&I centres, all of them integrated in the RVCTI, has ordered the priorities and competences of the main technological offer in the Basque Country. The strength of this Network and its Alliance, with thousands of researchers, lies in preferential and regulated access to public funding and the construction of an environment of trust and coordination between organisations. However, the focus of RVCTI and PCTI is above all technological-competitive, so there is hardly any room for 'Science and Knowledge for Policy', which is generally driven by Public Agencies of the Basque Government mentioned above.

Ihobe, as an environmental agency, assumes a central role, similar to an EU mission (de facto it coordinates the Basque Country within the framework of the Adaptation Mission). In reality, it manages or participates in the entire environmental policy cycle, i.e. from planning, design and management of instruments (especially economic and market instruments), the development of knowledge and its transfer, the platforms of companies and municipalities to encourage them to take action, and the monitoring of the results achieved.

Ihobe depends on the Vice-Ministry of Sustainability and the Vice-Ministry of Energy Transition of the Basque Government, having alliances with numerous Government Departments and most of the public and local entities, as well as with the main business associations and companies in the country. Ihobe promotes 'doing by doing', i.e. the collaborative deployment of environmental planning objectives with a focus on experimentation and innovation, due to limited resources.

The adaptation of a SRIA such as CASRI is necessary and welcome, but requires, at least in its most relevant aspect of 'Science and Knowledge for Policy', the securing of stable long-term funding as well as an improvement in the culture of evidence-based decision-making and the assumption of even greater risks to experiment with new innovative mechanisms.

Finally, it is recalled that the lines that have been marked out come from the interviews and working groups of the 2030 Environmental Framework Program with (PMA) and the Science, Technology and Innovation Plan PCTI 2030. The rest of the R&I lines were derived from the environmental plans themselves, from other priorities of the PCTI or from demands gathered from different stakeholders in the usual co-listening processes carried out by Ihobe.

2.1.2. Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Smart Economic Environmental Flows Data System (PCTI) Information at regional level on the flows of materials and emissions entering, leaving, accumulating, being consumed or moving within the value chains of the Basque economy is insufficient in terms of the degree of timeliness, their economic and environmental impact (Life Cycle Thinking & LCA). Environmental policy decisions are based on obsolete or low quality estimates, without any possibility of simulating scenarios or reducing the risk of decisions.	S,T	▪ Development of LCA specific eco-indicators to take strategic decisions (i.e. green hydrogen). Short term ▪ Prioritize public work programs for companies and consumers, depending on flows impact and improvement potential. Short term ▪ Simulate with AI support scenarios and effectiveness of new policy options and instruments. Short/medium term ▪ Monitoring results of policy decisions. Long term	R / N / E EU, but including Regions
Lowering Basque Metal Industry Environmental Footprint (PCTI) Basque industry revolves around metal (mainly steel, aluminium >copper). It is mainly based on secondary material which, due to decarbonization, is in high demand by large multinationals. Technological innovation is aimed at separating and processing complex, low-quality scrap to manufacture high-performance metals.	A	▪ Systematic eco-design of materials, parts and component based on metals. Short term ▪ Improvement of near net shape technologies. Short term ▪ Improvement of Steel and Aluminium scrap quality via advanced sorting technology, that ensures sustainable solutions for refusals. Short term ▪ Ensure the permanent magnet value chain. Short term	R
Expanding Product Value Retention Circular Business Models (PCTI) Increasing the durability of products requires a change in the business model, which needs to avoid value leakage of its products. Apart from the technological challenge, SMEs will lose their competitiveness if they	A	▪ Implementation of remanufacturing in long series of B2B and B2C consumer products in major companies. Short term ▪ Advanced repair of valuable high-alloy steel components, with optimised logistics. Short term	R / N

do not get funding to boost the servitization[5] of their products.		▪ Implementation of eco-design for durability in long series products. Short term ▪ Design of a public support fund to boost Sustainable Servitization (PSS) in SMEs, enabling access to finance. Short term	
Circularity in Value Chains (PMA/PCTI) Involve companies in the same value chain to develop demonstration projects of digital tools for the capture, sharing and data analysis on the use of raw materials and life cycle, which facilitate decision-making aimed at reducing the environmental footprint (Note: very related to the first priority of "Smart Economic Environmental Flows Data System")	T,A	▪ Identify value chains, strategic for the Basque economy and for progress in the circular economy and in the reduction of GHG emissions and environmental footprint (Short term) ▪ Develop a circularity index for circular systems that includes technical (material), economic, social, environmental and regulatory features. These features will allow to measure the capacity to move towards sustainable and systemic models and to perform diagnostics on the maturity/disposition/ challenges/capacities of companies/value chains/sectors to address a transition towards more circular (Short term) ▪ productive and logistics processes (similar to what is done to measure the digital maturity of companies and their proximity to technologies that define industry 4.0). (Short/Medium term) ▪ Define and develop digital tools for the automatic acquisition of pertinent information to ensure traceability of materials upstream and downstream in the value	R / N / E

[5] Sustainable servitization is basically "Product Service System", this means to see a product as a service, key to a new business model. De facto, if you produce long-lasting products, you can only survive with radical business strategies on services and product value retention

		chain, aligned with the new EU Digital Product Passport (DPP) (Short/Medium term) ▪ Legal and contractual environment that guarantees confidentiality and integrity of the generated information (Short term) ▪ Blockchain technology for information management between value chain agents, identification of business opportunities, adjustment between supply and demand and development of new service business models (Short/Medium term)	
Sustainability of Industrial Carbon Capture and Storage CCS (PCTI- Energy) The energy-intensive Basque industry contributes to almost 15% of total GHG emissions, making the design, development and demonstration of CCS solutions particularly relevant. Integrated monitoring (Euro, environmental and social) for the confirmation of the best techniques	S,A	▪ *Evaluation of LCA based Best Available Technology on CCS for Steelworks, GHG emitting energy production, Foundries and Cement kilns (Short term)* ▪ *Promotion of proven BAT technologies by transferring them to the European Innovation Centre for Industrial Transformation and Emissions (INCITE) de la UE (Short/Medium term)*	R / N / E
Global Smart Grids Innovation Hub (PCTI -Energy) The commitment to electrification as a condition for decarbonization requires innovative management of the entire grid, reducing risks and simulating scenarios for uncertain situations.	A	▪ *Sandboxes and testbeds on digital Smart Grids in close public private partnerships (Short term)*	R / N / E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

The establishment of the 6 priorities comes basically from the PCTI, both from the R&I working groups on ‘smart industry’ and ‘clean energy’ lines. It has also included the consensus derived from the ‘eco-innovation’ working group in its technology facet, finalized in spring 2024 with the participation of more than 60 experts from 42 companies and R&I agents.

In the four most recently finalized working groups (metal, plastic, building materials, product value retention) the priorities to be addressed in a collaborative way have been established and the main barriers in the value chains have also been reviewed, including technical, environmental, regulatory, financial and market barriers.

The existence of the Circular Eco-innovation Program managed by Ihobe with more than 200 industrial projects in recent years (30/year) with clearly defined priorities and the Elkartek (TRL 3-5, collaborative, Institute lead) and Strategic Hazitek (TRL 4-6, collaborative, enterprise lead) programs, both with approximately 10 large sustainable technological projects per year, have contributed to consolidating circularity and decarbonization in the company, generating benchmarks to follow and a collaborative inter-company environment.

However, K4P has not been adequately addressed, with the establishment of a ‘Smart Economic Environmental Flows Data System’ being the most prominent need still unaddressed. Other areas, not included in the list, are innovation in environmental taxation, the establishment of financing mechanisms to boost Product Service Systems in SMEs or the development of end-of-life criteria for different waste streams.

On a technological level, the collaboration and coherence of R&I's actions is focused on the eco-design of metal and construction materials as well as on closing their cycles, in addition to a commitment to the durability of products through eco-design and product value retention.

On the other hand, the commitment to decarbonization, within the framework of the Zero Basque Industrial Super Cluster, has focused R&I on Smart Grids as well as Industrial Carbon Capture and Storage.

2.1.3. Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Comprehensive models and data-driven approaches (Economic, Environment, Social) to validate alternative climate adaptation solutions to be demonstrated and transferred (PCTI) Concrete decisions and investments for climate adaptation have a very long-term effect and usually constitute investments in infrastructure or Nature Based Solutions (NBS). The best solution from a palette of alternatives for each case (and each case) should be selected on the basis of criteria based on economic, environmental and social data, in scenarios derived from excellent simulation models properly treated with IA that also integrate the Social Return on Investment (SROI) (see figure 2-3 of this document).	S,T,A	Achieve maximum cost-effectiveness of demonstrators of best transferable climate resilience and adaptation solutions. This entails methods to make the right decision on which solution is the most appropriate alternative and, unless it is a major one-off challenge, is widely transferable at even lower cost. Decision criteria must go beyond environmental criteria and be based on AI-supported models that are also based on rigorous data. (Short term)	R / N / E
Cost-effective soil quality monitoring system (PCTI) Launch of a public leadership project shared by the main Basque administrations involved (self-financed or with contributions from innovation programs) aimed at designing the data system in detail, its operations and carrying out a first pilot test, following the guidelines of the pre-design carried out.	S,T,A	▪ To cost-effectively monitor soil quality and its sink functions (Short/Medium term). ▪ To provide information for decision-making in both policy design and deployment and spatial planning (e.g. through the different instruments of spatial planning and urban planning). The latter aspect will be crucial in order to make the system as functional as possible (Short/Medium term). ▪ Assessing the evolution of soil health (Short/Medium term)	R / N / E

Integration of science-based climate resilience and soil protection criteria in key spatial instruments (EIA, Spatial Planning Guidelines,...) (Basque Climate Law) The main instruments driving the long-term transition towards climate resilience and soil protection are spatial planning (incl. urban, sectoral, territorial - partial) as well as environmental impact assessments (EIA). There is an urgent need to improve the data-driven methodological basis (criteria) to adequately integrate the two challenges with a holistic view in the different environmental policy instruments.	S,T,A	Achieve a critical mass of Agencies in Europe that have piloted new criteria and methods to integrate climate resilience and soil protection into at least two spatial instruments, Environmental Impact Assessments (EIA) and spatial planning. (Short term)	R / N / E
Advanced Measurement and Integration of territorial data on climate adaptation mainly (and related to soil management related climate mitigation, as LULUCF[6] does) in Copernicus - Bottom Up (PCTI) Some regions or spatial areas in the EU have spatial data needed for adaptation, protection or biodiversity at a higher level of detail and quality than satellite data. Decisions to be taken depend on the data they work with and can be contradictory. The orderly feeding of regional data into global EU models would facilitate coherent decisions (e.g. river flood risk analysis).	S,T,A	Develop and pilot replicable territorial measurement methods for integration into Copernicus, establishing protocols that allow their systematic integration under given conditions, always in agreement with the Copernicus data management entities. (Short term)	R
Innovative data services on climate adaptation mainly (and related to soil management related climate mitigation, as LULUCF does) for early warning and spatial planning based on Copernicus - Top Down (PCTI)	A	Generate advanced services for key users based on Copernicus data, to be piloted in the Basque Country in order to validate its response to real problems, in order to subsequently enhance its value in the EU. (Short term)	R / N / E

[6] https://unfccc.int/topics/land-use/workstreams/land-use--land-use-change-and-forestry-lulucf

Systematics to ensure excellent monitoring of demonstration projects in climate adaptation and highly effective transfer of knowledge and experience Demonstration projects are implemented in order to validate the environmental, social and economic feasibility of a solution and, if necessary, to improve it. Monitoring during the project and in the medium to long term whether the effects are as expected will increase the success of the subsequent transfer of the solution. Methodologically, there are still important gaps in the approach to monitoring.	A	This is actually the second part of the first point in this table. While the design of the demonstrator may be appropriate, only the measurement and evaluation of the demonstrator in the medium to long term will confirm the effectiveness of the new solution and its suitability for transfer.	R / N / E
Territorial Digital Twins Simulation on the basis of information on the Territory existing at a given time (this is a priority closely linked to others in this list).	A	To be able to simulate, based on GIS territorial data, different scenarios depending on climatic or anthropogenic changes in order to have a basis for designing the most appropriate actions in the long term.	R
Artificial Intelligence for early warning and digitisation for primary climate risks based on territorial data (PCTI) Need to have dynamic and agile on-the-fly solution proposals with AI support (this priority is closely linked to the first priority of 'Comprehensive models and data-driven approaches'.	S,T,A	Applying artificial intelligence to spatial data to respond quickly and efficiently to emergencies and spatial planning.(Short term)	R / N / E
Sustainable Cohesion of the Territory (PMA) Creation of a collaboration system between public and private entities to maintain and promote multitasking of the territory to: ▪ Guarantee the ecosystem services of the territory. ▪ Promote balanced social and territorial development. ▪ Preserve the landscape diversity of the Basque country.	A,T	▪ Identify the different situations in the preservation in sub region, as well as the structure in land ownership. ▪ Establish criteria for the identification of multifunctional areas that guarantee the capacity of the territory to optimize the provision and maintenance of multiple ecosystem services. ▪ Correctly define what a compensation system could consist of and what are the multifunctionality criteria	R

▪ Emphasize the importance of the territory as a source of well-being. ▪ Facilitate and significantly progress in the development of Green Infrastructure Strategies. ▪ Achieve effective inter-institutional coordination		to be compensated, using formulas or models to compensate good practices through specific funds, tax formulas, and other technical parameters. Perform strategic monitoring of the operation of the different formulas. ▪ Provide strategies and give continuity to the promotion work of green infrastructures. ▪ Develop a participatory process with local institutions and citizens to assess possible pilot projects. ▪ The compensation should encourage both the maintenance of existing good practices and the elimination of bad practices (Medium term)	
Prediction and Early Warning for Critical Infrastructure (PCTI)	S,A	Demonstrate cost-effective climate resilience solutions for the different Basque critical infrastructures. (short term)	R
Extreme event coastal emergency modelling and scenarios (PCTI) Extreme coastal events (waves, storm surges) and their impact on infrastructure and cities are currently one of the key climate adaptation challenges.	S,T	Demonstrating the effectiveness of early warning and sustainable coastal emergency solutions Short-term: it´s very advanced, a priority and high R&D efforts already done	R
Optimisation of hydrological models (incl. drought, water stress and salinisation) (PCTI)	S,T	Optimising water resources management through innovative modelling Short-term: it´s very advanced, a priority and high R&D efforts already done	R
Development of Land Stewardship/Contract Mechanism (PCTI)	S,T	To demonstrate land stewardship as a public-private land protection instrument. The expected result is a	R / N

		method agreed with the financial world and the public sector. Short term. Likewise, to establish an agreement that enables and regulates these actions by establishing a public guarantee, especially relevant in the forestry environment. Long term	
Integral solutions (NBS,...) to drought and erosion of agro-forest soil and soil protected by the Natura Network. (PCTI)	A	Demonstrating increased climate resilience in the protected and agro-forestry domain through NBS Short-medium term	R
Carbon sinks in forestry (PCTI) This priority is included in the key priority 'Cost-effective soil quality monitoring system'. It is particularly relevant due to the entry into force of the LULUCF Directive.	S	LULUCF real implementation of ambitious net carbon removal targets (aligned with national plans targets and promoting sustainable land management practices and carbon farming schemes), ensuring synergies for Climate & Biodiversity and developing advanced monitoring technologies. Short-medium term	R / N / E
Agro-ecotech for regenerative agriculture that sequesters carbon and boosts biodiversity (PCTI)	S,T,A	Demonstrating the feasibility and carbon sequestration of technologically advanced regenerative agroforestry Short-medium term	R / N / E
Integration of science-based climate resilience and soil protection criteria in relevant economic instruments such as DNSH or green taxation The Basque Country has a high potential to use taxation as a green instrument, but has not designed and implemented it in the field of climate resilience and soil protection.	S,T,A	Integrate tax deductions for climate resilience and soil protection into corporate taxation, and translate the same criteria into the DNSH so that financial institutions can speed up advantageous loans. Short-medium term	R / N / E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

The intensive work carried out by the Basque Country in the framework of the EU Climate Adaptation Mission for its previous Integrated Life Urban Klima 2050 has detected, together with the interviews carried out in the framework of the establishment of priorities of the PCTI 2030, a large number of 17 priorities.

The limited Basque involvement in the EU Soil Mission due to lack of resources hampers R&I in soil protection, especially since the R&I expert group on contaminated soils was dissolved almost a decade ago.

There are basically three needs. First, a need (see figure 3) to design and pilot methods to improve the impact of existing and public instruments (EIA, Spatial Planning, Emergencies,...) for which European inter-agency collaboration is considered fundamental. Secondly, to ensure that the solutions proposed are really the best in the long term from an integral approach (economy, social, environment) and based on dynamic models and scenarios.

Thirdly, this requires intelligent development and exploitation with AI of data, some of which does not even exist. Several of the priorities set actually fall into the first three, the most relevant ones, such as ‘Comprehensive models and data-driven criteria (economy, environment, social) to validate alternative climate adaptation solutions to be demonstrated and transferred’, a ‘Cost-effective soil quality monitoring system’ and the ‘Integration of science-based climate resilience and soil protection criteria into key territorial instruments’.

2.1.4. Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Comprehensive (economy, environment, social) urban regeneration criteria for long-term sustainable data-driven decisions. Urban regeneration must include not only long-term environmental criteria, but also economic and social criteria. In addition to the lack of adequate methods, there is a lack of data and models that, using AI, can simulate different dynamic scenarios in order to make comprehensive decisions by selecting between different alternatives.	S,A	▪ Develop comprehensive methods for urban regeneration, in particular establishing knowledge-based criteria for (Short term): ○ sustainable urbanization of land ○ protecting soil functions and terrestrial ecosystems in the urban environment ○ implementing land use targets ▪ Establish a dynamic data-driven model to simulate multiple scenarios (Medium term) ▪ Develop an intelligent decision support for urban regeneration based on different alternatives (Short term) ▪ Establish an environmental, social and economic impact monitoring system for the implemented alternatives (Short term). All of this should lead us in the long term to a radical urban transformation as set out in the Urban and Territorial Planning Guidelines.	R / N / E
Heatwave and flood prevention and mitigation in urban and peri-urban-industrial environments (PCTI). The two extreme events that are increasing in frequency at the municipal level are floods and heat waves. The new Basque Energy and Climate Transition Law requires Adaptation and Resilience Plans at local level within a given timeframe. The criteria for decision-	S,A	▪ Develop methods for selecting the most environmentally, economically and socially advantageous long-term solutions based on data and simulated models (Short term). ▪ Coordinate actions between emergency, health, urban planning, works and environment at regional and, in parallel, local level (Short term).	R / N / E

making to reduce these impacts in the long term and in the most sustainable way are not sufficiently robust.		▪ Demonstrate the feasibility of advanced solutions to heat waves and floods in urban and peri-urban environments (Short term). ▪ To widely transfer the solutions demonstrated to Basque municipalities via Udalsarea 2030 (Medium term).	
Innovative and efficient management of vacant land in urban or developable areas at local level (PCTI). Deploy the selected working method on vacant land management on a pilot scale in several representative Basque municipalities , as a prior step to the promotion and boosting from this method through the Udalsarea 2030 Network of Basque municipalities.	A	▪ Establish criteria for applying land take targets beyond vacant land (Short term). ▪ Reduce land consumption. Zero net degradation by 2050 goes hand in hand with land take neutrality through, among other actions, the reuse of disused anthropized sites. (Long term). ▪ Manage land take from a global perspective. The occupation of undeveloped or agricultural land is avoided, anthropized land is reused through the assignment of new uses or its renaturation, and its effects are compensated or mitigated when land take is unavoidable (Long term). ▪ To protect development from harmful impacts. In order to implement new uses and protect them from hazards, soil characteristics and vulnerability are considered together with soil ecosystem services. (Long term) ▪ Restore degraded soils. Degraded soils are, whenever feasible, rehabilitated in order to recover their functions, taking into account their location (Long term). ▪ Improve awareness and knowledge of professionals on the topic of land take and citizens (Short term).	R

Social Innovation and innovative deliberation processes for Sustainability (PCTI/PMA). ▪ The new Energy Transition and Climate Basque Law establishes deliberation processes as a key instrument. ▪ Comprehensive information system (health, social, environmental and economic), open and transparent where large data sets allows fair and efficient decision-making. ▪ Advanced models of social deliberation on environmental sustainability will allow to take a new step in the model of citizen involvement making society feel heard, provide citizens with the necessary tools and encourage networking between people and interested entities. ▪ Facilitate social co-responsibility, where children and youth play an essential role in ensuring the future of sustainability.	S,T	Demonstrate the real effectiveness of deliberative processes and their contribution to a just climate transition, by (Short term): ▪ Comprehensive, open and transparent information system ▪ Social involvement advanced models ▪ Social co-responsibility of childhood and youth	R / N / E
Developing sustainable industrialized construction (PCTI) Building material is one of the main destinations for secondary material. New building materials are increasingly complex and multi-material in makeup. Industrialized construction is, in principle, much more sustainable and involves a change in economic relations as well as having a social impact. It requires new standards, regulations and economic flows.	A	▪ Development of a new manufacturing industry of 2D and 3D eco-designed modules for industrialized construction. Short term ▪ Creation of a sustainable value chain in industrialized construction. Short term ▪ Development of technical standards that favor sustainable industrialized construction. Short term ▪ Models of contracts and economic transactions that take into account LCA and LCC (Life Cycle Costs) in their entirety. Short term	R / N /E

Development of criteria for a new housing model social rental housing as a public service (PCTI Cities) The 2030 Housing Plan provides for the promotion of social renting. By extending public responsibility from housing construction to the use and end-of-life phase, green public procurement can integrate LCA and LCC (and in the future LCA) criteria and better link this model to local urban planning.	S,A	It is expected to reduce the environmental impact, especially in terms of GHG and materials consumed. The new housing model also implies a radical change in the renovation and construction value chain, which is generally very reluctant to innovation. This change will generate winners and losers. To be sustainable, it will have to be managed in advance (short term).	R
Monitoring of the implementation and impact of DNSH ("Do No Significant Harm") criteria in built environment, cities and infrastructures The EU's green taxonomy gives priority to the renovation and construction of housing, buildings, works and infrastructure. However, the current criteria are not sufficiently precise to be deployed in practice.	S,T,A	Improve the conditions for public and private financing of investments in built environment, cities and infrastructures, following the use of the DNSH, especially in the field of adaptation, but also of climate mitigation, circular economy, biodiversity and water. Reinforcing the value of the DNSH also involves an increasing use of private financing for the public sector, a field still hardly used in the Basque Country (Short / Medium term).	R / N / E
Establishment of a Testbed and Living Lab for the remediation of contaminated soils. (PCTI) Ensure reduced environmental impact with cost-effective solutions that are simulated and demonstrated in pilot installations coordinated in a network with existing EU installations.	A	Accelerate the remediation of contaminated soils in the Basque Country with the support of a Testbed coordinated with the best international experimental facilities (Short term).	R

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The establishment of the 8 priorities comes basically from the PCTI, some of them coming from the technological line. In the Ihobe core group's reflection on priorities, priority has been given to ‘Integral criteria (economy, environment, social) of Urban Regeneration for long-term sustainable decisions based on data’ which, in fact, encompasses several of the priorities such as ‘prevention and mitigation of heat waves and floods in urban and peri-urban-industrial environments’, ‘Social innovation and innovative deliberation processes for Sustainability’, the ’development of criteria for a new model of social rental housing as a public service’ or the ’Innovative and efficient management of vacant land in urban areas at local level’.

Finally, it is worth highlighting the relevance of the consolidated Udalsarea 2030 Network of Basque municipalities, which carries out innovative methodological projects and develops demonstrators to transfer the results achieved.

2.1.5. Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Deployment of renewable energies and balance in its implementation with social justice, territorial management and the protection and conservation of biodiversity Based on the current and ongoing regulatory package how should the interaction of the deployment of renewable energy with the necessary environmental protection, including the preservation of biodiversity, be addressed. Territorial planning models would be a priority in order to optimize the integration of energy objectives with those of sectoral and environmental policies	T	▪ Developing criteria for fair use in the energy transition process (Short term) ▪ Addressing the challenge of Nature- and Environmentally Friendly Energy Transition (NEFET) by considering the regulatory framework set forth by the European Green Deal (Short term) ▪ Positive Narratives and Win-Win Approaches to achieve NEFET (Short term) ▪ Strategic Approach and Energy-Based Spatial Planning: Shifting from an installation-based approach to a strategic approach like energy-based spatial planning (Short term) ▪ Implement renewable energy installations (incl. transport, conversion, distribution, etc.) with robust and inclusive assessment methods, leading to relevant data considering both environmental and socio-economic impacts along all the stages of the life cycle of the infrastructure (Short term) ▪ Addressing Land Use conflicts and opportunities: Tackle conflicts arising from land use and the development of renewable energy installations by considering at the regional level the contradictions between nature conservation policies and net-zero emissions' policies (Short term)	R / N / E

		▪ Considering broader infrastructure issues exploring the challenges and opportunities in the development of renewable energy projects and relates to the consideration of the necessary increase in clean technologies production on European soil and waters and potential social responses to such installations while respecting environmental imperatives. ((Short/Medium term)	
Ensuring the sustainability of hydrogen in energy-intensive industrial sectors. The Basque Country is one of the 20 regions of the European H2 Valley. The Basque strategy has to ensure that the environmental (LCA) and cost (LCC) impact of the whole chain is really as green as expected.	A	▪ Confirmation that the hydrogen production process in the Basque Country and its use have a minimum environmental impact, following international calculation methods. Short term ▪ Develop specific eco-indicators on a regional scale to enable appropriate decisions to be taken, and integrate them into international systems (Ecoscan, Recipe,...). Short term	R / N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

R&I in the nature & environmentally friendly energy transition has been approached in the Basque Country from a fundamentally technological point of view. The sustainable, systemic and integral aspect has hardly been developed, except for the integration of Life Cycle Thinking in the main companies of the energy sector of the public-private platform Basque Ecodesign Center (Iberdrola, Petronor - Repsol, Edp, Siemens Gamesa and Ormazabal). This has led to relevant environmentally sound decisions on renewables and energy storage. On this basis, it is considered relevant to ensure, from an LCA approach, the suitability of large investments in decarbonization and the hydrogen economy in energy-intensive industrial sectors. However, the most relevant need in terms of the need for knowledge-based criteria is the development of the deployment of renewable energies and balance in its implementation with territorial management as well as the protection and conservation of biodiversity, which can be improved in line with new scientific and knowledge developments.

2.1.6. Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
One Health Environment Observatory (PMA) Improve knowledge on the link between health and environment in the Basque Country as a basis for better decision-making, by creating a common area where to centralize and give coherence to all this information and knowledge.	S,T	▪ Benchmarking with other countries or regions that already have systematized models for monitoring health and the environment and synergies with pilot projects that may be developing in the environment (Short term) ▪ environmental features of health, both physical and chemical and biological, and of features linked to them (features of exposure to the urban environment, psychosocial features, of climate-meteorological change, of exposure to toxic substances, of factors of biological origin,…) (Long term) ▪ methodology on health impact features from the point of view of one health (Medium term) ▪ Stabile expert analysis on health and environment to analyses results for the design and implementation of preventive environmental health measures (Medium term) ▪ University training in scientific and technical studies, health sciences and social sciences within the field of health and environment (Medium term)	R / N / E
Monitoring of emerging pollutants (PCTI) The need to launch a public leadership project shared by the Basque administrations involved (health, water, etc.), self-financed or with contributions from innovation programs, aimed, in the first instance, at gathering	S,T	▪ Development and implementation of specific cost-effective pollutants plans (PFAS,…) (Medium term) ▪ Development of a cost-effective model to measure, prevent and reduce emergent pollutants on effluents and water, anticipating to the recently established regulation (Medium term)	R

information on the real impact of emerging pollutants (PFAS,...).			
Ciencia Ciudadana en Biodiversidad, Contaminación Cero y Calidad del Suelo (PCTI) EPA Network has hardly worked on Citizen Science via its Interest Group. Several unconnected initiatives are going on, but synergies between initiatives and contribution to regional environmental planning goals are lacking	A,T	Involve citizens in the collection of scientific data for environmental protection and resilience. Specifically: ▪ Map knowledge needs that can be met by citizen science as well as relevant local and international initiatives (Short term). ▪ Prioritize areas in which to advance citizen science (Short term) ▪ Establish a mechanism, partnerships and resources to support efficient and effective deployment of self-managed citizen science based on best international models (Short term)	R / N / E
Citizenship and sustainable consumption (PMA) Empower Basque citizens in their role as consumers as a lever for changing the products and services they acquire, to achieve a more sustainable production and consumption model in a coordinated manner.	S,T	▪ Design priorities and the promotion of sustainable consumption in the Basque Country via a focus group between local supply agents, the distribution sector, consumer organizations and the administration to jointly (Short term) ▪ Jointly designed innovative tools to transform the current production and consumption patterns towards a more sustainable model, ▪ Innovative incentives and accompanying plans for producers, distributors and commercial establishments ▪ Identify with producers and their value chains those actions that could improve the sustainability positioning of their products and services ▪ Development of tax deductions on the income tax to foster sustainable consumers (Short term)	R

Sustainable Finance (PMA) Transform our economy so that it is more sustainable, adding the Basque financial system in this process. It will also promote the quick adaptation to new EU Regulation on the establishment of a framework to facilitate sustainable investments (public ones and also privates, especially this supporting SMEs)	S,T	▪ Measurement of the level of alignment of the Basque Government's budgets with the Taxonomy (Short term) ▪ Diagnose the initial situation in the Basque Country addressing the performance of Transition Maps by economic sectors (Short term) ▪ Deploy exchange formats with other European regions to share knowledge and experiences (Short term)	R / N / E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

There are many cross-cutting areas of R&I in sustainability that came up in the interviews. In addition, the PMA and PCTI working groups defined transformational projects which, if they could not be included in the four previous sections, have been included here. It should be noted that the PMA transformative projects have their own funding through Ihobe.
The cross-cutting areas stand out for their approach to health (which in the PCTI is only addressed from a technological aspect) or for their focus on citizen involvement, apart from a global vision of sustainable finance.

2.2 Promising funding schemes

The main funding mechanisms (there are other minor ones) in the Basque Country come mainly from regional budgets (co-financed in a % under EU Cohesion Funds). Programmes with higher TRLs and led by the public sector with expert monitoring by an Agency in order to achieve regional environmental objectives (1,2,3) have the highest effectiveness even though they only account for 10% of annual expenditure.

It is worth noting that more than 60% of R&D&I funds are directed to the business technology field, while barely 15% is directed to K4P and less than 10% to S4P. The EU programmes (Horizon, Life), which account for a third of R&I spending, are mainly led by technology centres and institutes rather than by public or private demand, so effectiveness, with some exceptions, tends to be lower.

TABLE 2-1: MAIN SOURCES OF R&D&I FUNDING IN THE 4 CASRI AREAS. THE ANNUAL FUNDING (53 MILLION €/YEAR) REFERS TO PROJECTS IN THE ABOVE-MENTIONED AREAS. THIS TABLE DOES NOT INCLUDE THE 35% TAX DEDUCTION FOR BUSINESS R&D, WHICH AMOUNTS TO APPROX. 15 MILLION E/YEAR ADDITIONAL FUNDING.

Program	R/N/E/I	Million €/year	S4P /K4P	TRL	1. Net 0 Circular Prod	2.Biodivers & Climate	3.Sustain. Urbanisation	4. Energy Transition
1.Klimatek	R	1	K4P	6-8		Government		
2.Ihobe K4P (Tenders)	R	2	K4P	6-8	Government	Government	Government	
3.Circular Eco-innovation	R	2	-	5-8	Business			
4.Excellence RTD	R	2	S4P	2-4		Government		Government
5.Universities RTD Fund	R/N	(4)	- / S4P	2-4				
6.Hazitek (Strategic/Competitive)	R	7 +9	-	4-6 / 5-7	Business			
7.Elkartek	R	8	-	3-5	Institutes			
8.Horizon	EU	11	- /S4P /K4P	3-5 / 6-8	All	All	All	All
9.Life	EU	7	-/ K4P	6-8	All	All		

The thematic areas least covered are ‘Biodiversity & Climate’ and ‘Sustainable urbanisation’, which between them receive only 26% of funding compared to 64% for ‘Resilient, net-zero, circular production systems’. Although ‘Nature & environmentally friendly energy transition’ appears to receive 32% of the funds, in reality these are projects and initiatives that do not generally focus on the sustainability of the energy transition, but on technological development per se.

Several ideas are being considered for 'promising new funding schemes that CASRI could use':

- **Cross-contributions to projects (TRL 7-8 in K4P):** by sharing months in advance the innovation portfolio of each agency in areas of interest to CASRI, simple synergies can be created (Advisory Board, Benchmarks, Exchange Forums, data comparison,...) that with little effort offer a lot of value. This option can already be promoted directly
- **Implementation of collaborative agile projects (TRL 6-8 in K4P):** establishment of a new simple and attractive mechanism (learning from the mistakes of the ERANET mechanism) that facilitates the integration of an own budget for the projects that an MS is interested in. The SOILVER model can be a reference for this, but ensuring a prior commitment at the management level of the different agencies. This scheme is agile and totally focused on objectives. The legal possibility of signing collaboration agreements between public agencies that include budget items should be considered, thus simplifying project financing.
- **CASRI projects with private or public-private funding (TRL 3-5 and 6-8):** there is the possibility of generating an Agency Network Fund in which different green funders (e.g. Norwegian Sovereign Wealth Fund, Greater Manchester Environment Fund model,...) invest, which at the same time reactivates co-financing with regional or national budgets, but ensuring the independence of the fund itself. EU co-financing could reinforce confidence in an own fund of agencies developing common R&I projects.
- **Joint application to Horizon Europe, FP 10 or Life (TRL 6-8 in K4P):** after analysing the specific issues of each Horizon call, consider addressing some of them of particular interest through inter-agency collaboration, hiring an excellent manager as technical assistance. This option can already be promoted directly.
- **Promotion in the EU of a complete line aimed at Agencies in the future Green Transition FP 10, developed with the EPA Agencies**: CASRI and the EEA should work together to ensure that the new FP 10 includes a specific line of RDI in Green Transition in the design of which the NEPAs Network is fully involved together with other entities. This approach is the most interesting but at the same time the most complex and it may be advisable to integrate it into the Horizon / FP 10 Missions.

Arguments to persuade regional funders to strengthen their financial commitment to CASRI collaborative projects could be:

- the prestige of international collaboration with the most recognized agencies incl. the EEA (which shields own budgets for co-financing even in post-election changes),
- the possibility to propose or influence European environmental policy on the basis of inter-agency collaboration.
- a better defence in one's own country or region against opposing interests or corresponding lobbies
- the selection of the best experts at European level to carry out highly complex tasks
- the ability to compare the results of one country or region with others, by applying the same working methodology.

In short, an optimal cost-effectiveness ratio as long as the urgency of the K4P or its geographical specificity is not relevant.

2.3 Improving the Science Practice Policy interface (SPPI)

There is room for improvement in communication between science and policy. Depending on the geographic environment, the personal component (mood and training) influences this communication. The projection of current affairs in the media and the public in the short term has a great influence on policy, so that there are strong short-term tendencies, which are aggravated if there are changes of government in a short period of time. On the other hand, science has difficulties in conveying its results in a simple, simplified and pedagogical way, although it is improving (e.g. The Conversation7).

The Basque Country as a small region, similar to Slovenia in terms of population, can only invest in S4P in the long term in very specific niches (e.g. currently in marine biological & biotechnological resources or electrochemical energy storage). Potential R&D&I in transitions, which is practically non-existent, would also have to focus on a narrow field. As a result, much of the in-house R&D&I is more focused on higher TRLs and K4P, which responds to the territorial needs of environmental policy in the 'short term', i.e. 10 years at most.

The participation of policy in events that present science and knowledge results and vice versa (participation of science in environmental policy planning processes) are the most operational mechanisms currently used in the Basque Country. Another recurrent route is that the Environmental Agency itself transfers the results of science to policy, including an assessment of different operational response options. Strengthening the synergy between science and policy is a task that should be undertaken by the Environment Agencies. Suggestions include:

- Each country or region has a different cultural casuistry (apart from language), so messages must be adapted to each reality (although a global forum for the EU can be maintained).
- Create selected forums, in which emerging CASRI issues and with a focus on the EEA DSPIR model, bring knowledge closer to public decision-makers and politicians in government and opposition. The EEA can play a key coordinating role
- Create forums for science (preferably by geographic areas) in which complex policy management is made to be understood (exercises, role-plays,...). This approach is less thematic.

2.4 Recommendations for CASRI by NKS

The interviews were conducted before Ihobe joined CASRI and before the questionnaire was available. For this reason, the minutes have been reviewed and some of the suggestions that are considered to contribute to this section have been included, understanding CASRI as an environment of inter-agency collaboration to promote Science and Knowledge for Policy of common interest with maximum effectiveness. According to those interviewed (without representatives of funds), it can be summarised as follows:

[7] https://theconversation.com/europe; one of the most relevant platforms for EU universities to promote Knowledge for Society

Scientific-technological environment: having clear buyers for S4P and K4P developments increases the value and impact of R&D&I projects, as well as their transferability. The interest of the scientific-technological environment depends on the expected funding and on how simple and attractive the mechanisms are sold.

Public administration: collaborating in the process of developing complex innovative S4P and K4P projects with other Agencies is of high interest. There are two recent platforms, the Technical Commission for Soil Protection and the new Climate Change Office with its Scientific Committee that could actively participate or be involved in CASRI project proposals.

The Administration requires higher TRLs, i.e. closer to K4P and less to S4P. As shown in Figure 2-3, the public priority is innovative and rigorous methodologies for regional application with benchmark endorsements that reinforce sustainability in existing (or new) environmental policy instruments.

On the other hand, new environmental, social and economic criteria are essential for long-term sustainable decision-making on infrastructures or territorial developments, which should generally be tested in demonstrators with high transferability or high potential impact, after carrying out the corresponding simulations and scenarios.

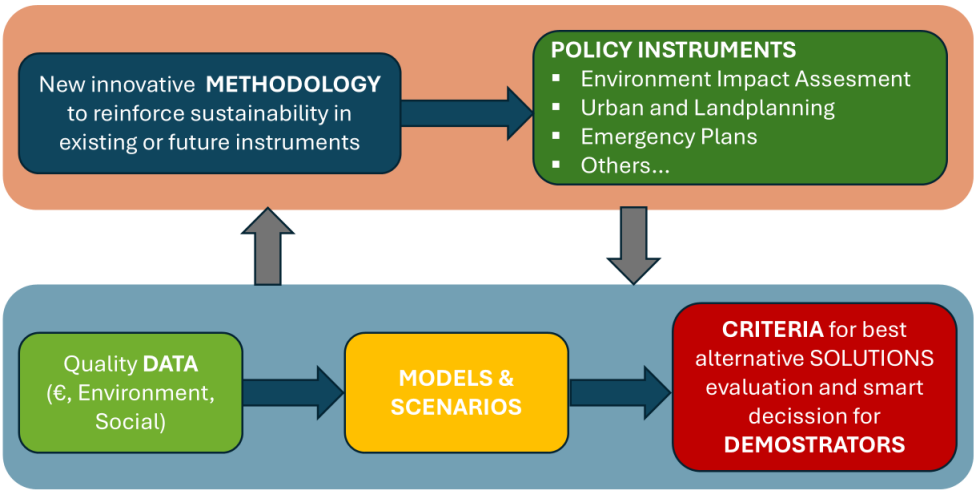

***FIGURE** 2-3: CONCEPT OF KNOWLEDGE NEED IN THE PUBLIC SECTOR FOR BETTER DEVELOPMENT OF ENVIRONMENTAL POLICY INSTRUMENTS (INNOVATIVE METHODS) AND DECISION MAKING OF TRANSFERABLE DEMONSTRATORS BASED ON DATA AND MODELS OR COMPREHENSIVE SCENARIOS.*

Companies and clusters: There are no significant synergies in the technological aspect; however, there is some interest in developing foundations to pilot, improve, or standardize environmental policy instruments at the European level (EIA, economic-environmental data, etc.), since the European market is the most relevant. In the Basque Country, there is no Science, Research, and Technology Council that establishes clear national priorities for the different funding mechanisms, which, except for some minor ones, are non-thematic and decided based on the technical criteria of the Funding Programs. This is considered a significant pending issue.

2.5 Reflection on the workflow

There is good quality information on 'Resilient, net-zero, circular production systems' and on 'Biodiversity and climate' (less so on biodiversity), but rather less on 'Sustainable urbanisation' and 'Nature & environmentally friendly energy transition' due to the focus of the meetings held at the time. The lack of representatives from universities and civil society in the discussions, as well as from the 'non-thematic' funding funds, is noted. In addition, the CDTI works as the Spanish representative (in coordination with the TAFTIE network) in establishing RDI priorities at EU level, so an in-depth interview would have been desirable. Although national funding mechanisms exist, they have a low impact in the Basque Country. It should be noted, as a detail, that in the tables with R&I priorities, it was difficult to establish the 'kind of knowledge needed' column and the 'level where the impact takes place' column, so the quality of the proposals in this report is limited.

It would have been desirable to re-map all ongoing projects in the Basque Country with the help of the IA. However, the lack of experience in this field and the lack of necessary resources prevented this. The work has focused on interviews, which in all cases have been carried out in groups. In the technology areas, representatives of 42 organisations participated in 4 working groups, while in the S4P and K4P areas, a total of 29 people participated in specific meetings with 11 entities. In addition, around 80 people took part in the prioritisation of the LDC's transformative innovative projects, the conclusions of which were also fed into this work. The workshop was not held so as not to interfere with other participatory processes underway with many of the same entities.

Had Ihobe had more resources, it would have carried out additional interviews, especially with universities and various entities representing society. In case of going back and having more resources, Ihobe would have standardised the complete map of environmental R&D&I projects in the Basque Country and analysed both their alignment with environmental planning as well as their potential 'candidacy' to become a transformative project in CASRI. A workshop would be desirable but the object and focus would be established more concretely.

Finally, the advantage of Ihobe being a small agency for a small region has the advantage of constant contact with numerous stakeholders who communicate their needs (incl. those of R&I) so that environmental policy can be adapted as quickly as possible through experimentation and, in case of success, the deployment of new instruments and initiatives for circular, climate, environmental and energy transition.

3 BULGARIA – National Report

Authors: Ina Aneva, Dimiter Ivanov

SUMMARY IN BULGARIAN

Проект CASRI предлага задълбочен анализ на ключовите аспекти, които са от съществено значение за развитието на изследвания и иновации в областта на околната среда и устойчивостта (ES R&I) в национален контекст. Основните изводи се основават на подробен преглед на потребностите в четирите тематични области на CASRI, като същевременно отразяват националните приоритети и насочват вниманието към сектори, които изискват допълнително развитие. Там, където определени теми не са били напълно разгледани, това се дължи на ограничения в наличните данни или на продължаващи стратегически корекции.

- Национален контекст

Анализът подчертава специфичните особености на националната изследователска и иновационна екосистема. В България ключовите приоритети включват насърчаването на устойчиви и иновативни технологии, развитието на изследователски капацитети и сътрудничеството на национално и международно ниво. Развитието на изследователски инфраструктури и интегрирането на добри практики са сред основните предизвикателства.

- Прегледът на нуждите в четирите теми на CASRI разкрива следното:

1. Устойчиви, кръгови производствени системи с нулеви нетни емисии

Основните приоритети включват устойчиво управление на природни ресурси и намаляване на въздействието на климатичните промени.

2. Биологично разнообразие и климат

Необходимостта от подобряване на мониторинга на екосистемите и биоразнообразието е особено изразена.

3. Устойчива урбанизация

Развитието на интелигентни технологии за обработка и анализ на данни е идентифицирано като критичен приоритет.

4. Енергиен преход

Връзката между обществото и науката е централен елемент, особено при разработването на политики за устойчиво развитие. В случаи, където определени теми не са били напълно разгледани, това се дължи на липсата на достатъчно емпирични данни или на необходимостта от допълнителни консултации със заинтересовани страни.

- Финансови възможности

Проектът обръща внимание на съществуващите и потенциалните източници на финансиране, както са възприети от Националните ключови заинтересовани страни. Европейските програми като „Хоризонт Европа“, национални фондове и публично-частни партньорства представляват ключови възможности за финансиране на изследователски и иновационни дейности.

- Взаимодействие между наука и политика

Важен акцент е поставен върху взаимодействието между научната общност и политическите структури (Science Policy (Practice) Interaction – SP(P)I). Проектът подчертава необходимостта от по-активен диалог между тези страни, за да се улесни прилагането на научните открития в практиката и политиката.

- Други релевантни национални дейности

Проектът също така отчита редица свързани национални инициативи, които допринасят за устойчивото развитие и сътрудничеството между различни заинтересовани страни. Сред тях са развитието на иновационни клъстери, създаването на центрове за върхови постижения и интеграцията в международни изследователски мрежи.
Този доклад предоставя цялостен преглед на текущите предизвикателства, възможности и перспективи за развитие в контекста на CASRI, като служи за основа за формулиране на бъдещи стратегии и действия.

EXECUTIVE SUMMARY ENGLISH

The CASRI Project provides an in-depth analysis of key aspects essential for the development of research and innovation in the field of Environmental and Sustainability Research and Innovation (ES R&I) within the national context. The key findings are based on a detailed review of the needs across the four CASRI thematic areas, while also reflecting national priorities and directing attention to sectors requiring further development. In cases where certain themes were not fully addressed, this is attributed to limitations in available data or ongoing strategic adjustments.

National Context

The analysis highlights the specific characteristics of the national research and innovation ecosystem. In Bulgaria, key priorities include the promotion of sustainable and innovative technologies, the development of research capacities, and fostering cooperation at both national and international levels. The development of research infrastructures and the integration of best practices remain among the primary challenges.

Review of Needs Across CASRI's Four Themes:

- Sustainable, Circular Production Systems with Net Zero Emissions: The main priorities include sustainable management of natural resources and reducing the impacts of climate change.
- Biodiversity and Climate: The need for improved monitoring of ecosystems and biodiversity is particularly pronounced.
- Sustainable Urbanization: The development of smart technologies for data processing and analysis has been identified as a critical priority.
- Energy Transition: The relationship between society and science is a central element, especially in the development of policies for sustainable development. In cases where certain themes were not fully addressed, this was due to insufficient empirical data or the need for further consultation with stakeholders.

Funding Opportunities

The project emphasizes existing and potential funding sources as perceived by National Key Stakeholders (NKS). European programs such as “Horizon Europe,” national funds, and public-private partnerships represent key opportunities for funding research and innovation activities.

Science Policy (Practice) Interaction

An important focus is placed on the interaction between the scientific community and policy structures (Science Policy (Practice) Interaction – SP(P)I). The project highlights the need for more

active dialogue between these parties to facilitate the application of scientific findings in practice and policymaking.

Other Relevant National Activities

The project also considers various related national initiatives contributing to sustainable development and collaboration among different stakeholders. These include the development of innovation clusters, the establishment of centres of excellence, and integration into international research networks.

This report provides a comprehensive overview of current challenges, opportunities, and development prospects in the context of CASRI, serving as a foundation for formulating future strategies and actions.

3.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

3.1.1 National research context

Bulgaria's national R&I agenda aligns with key sustainability goals such as reducing greenhouse gas emissions, conserving biodiversity, and promoting circular production systems. Policies like the National Strategy for Research Development (2021–2030) and Bulgaria's commitments under the European Green Deal guide R&I efforts toward sustainable practices and innovations.

The current R&I infrastructure includes institutions such as the Bulgarian Academy of Sciences (BAS), universities, and regional innovation hubs. While these institutions demonstrate strong research potential and engagement in EU-funded projects, challenges such as limited funding, bureaucratic inefficiencies, and gaps in the commercialization of innovations hinder progress. Strengthening this infrastructure is critical for addressing sustainability goals.

The Bulgarian EPA plays a crucial role in implementing environmental policies and ensuring compliance with national and EU standards. Its activities include monitoring environmental indicators, reporting on biodiversity and climate targets, and supporting public awareness campaigns. Collaboration between the EPA and research institutions like BAS ensure that scientific findings inform environmental policies and practices. However, the agency's capacity to leverage cutting-edge R&I outputs is limited by resource constraints and administrative barriers.

Bulgaria presents a promising landscape for adopting the CASRI SRIA, particularly given its alignment with national priorities in sustainable development. The willingness to participate in EU-level initiatives such as Horizon Europe and LIFE, combined with ongoing efforts to modernize R&I infrastructure, underscores the feasibility of integrating CASRI SRIA into national strategies. Opportunities include fostering partnerships between academia, industry, and government, enhancing funding mechanisms, and prioritizing themes such as:

- Sustainable Circular Production Systems: Expanding research on resource efficiency and waste reduction.
- Biodiversity and Climate: Enhancing ecosystem monitoring and adaptive management strategies.
- Sustainable Urbanization: Developing smart cities with green infrastructure.

- Energy Transition: Supporting policies for renewable energy integration and public engagement.

The CASRI SRIA provides a strategic framework for addressing Bulgaria's unique challenges in ES R&I. By fostering collaboration, enhancing science-policy interactions, and leveraging funding opportunities, it has the potential to drive significant progress toward national and EU sustainability goals.

3.1.2 Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Climate change and biodiversity – the priority is urgent and important because of the unprecedently fast changes in global and local climate and inability of ecosystems to react within a short time	*S*	*In short term – action plans for conservation of fragile and endangered ecosystems and species* *In long term – change of the national and international (European) concepts and policies for energy supply and utilization of natural resources*	R, N, E
Waste management and reducing the environmental pollution – a problem of regional and national importance, which is becoming increasingly serious for Bulgaria	S, A	Short term – regional plans for waste management; improvement of the legislation concerning the problem.	R, N
Climate Resilience and Adaptation in Urban Areas - Urgent due to increasing climate risks impacting cities, requiring sustainable infrastructure and urban planning.	S, A	Short term: Enhanced urban resilience, reduced vulnerability to climate-related risks. Long term: Sustainable and adaptable urban environments.	R, N, E
Circular Economy Integration in Industrial Processes - Urgent to reduce waste and promote sustainable resource use, essential for long-term environmental sustainability.	A, T	Short term: Reduced industrial waste and resource consumption. Long term: Sustainable industrial systems with minimal environmental impact.	N, E, I
Water Resource Management and Conservation - Important due to growing water scarcity and the need for sustainable water use in agriculture and urban areas.	S, A	Short term: Improved water efficiency and reduced water stress. Long term: Sustainable water management systems that ensure availability and quality of water resources.	R, N, E
Enhancing Cross-Border Environmental Cooperation - Urgent to address shared environmental challenges such as water pollution, biodiversity loss, and climate impacts in the Danube region through collaborative research and policy alignment. (Interreg Europe / EUSDR)	S, A	Short term: Improved cross-border coordination in environmental management and pollution control. Long term: A resilient and sustainable Danube region with enhanced environmental quality and biodiversity.	R, E
Sustainable Agriculture and Food Security - Urgent to address food insecurity and ensure sustainable agricultural practices in the face of climate change.	A, T	Short term: Increased agricultural productivity and resilience to climate impacts. Long term: Sustainable food systems that ensure food security for future generations.	N, E, I

Digital Transformation for Sustainable Development - Important to leverage digital technologies for sustainability, enhancing efficiency and innovation in various sectors.	T, A	Short term: Improved efficiency and innovation in key sectors. Long term: Widespread adoption of digital technologies driving sustainable development across industries.	N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

3.1.3 Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Conservation and Restoration of Endangered Species in Bulgaria - Urgent due to the rapid decline of native species and ecosystems. Protecting biodiversity is critical for ecosystem stability and resilience.	S, A	Short term: Stabilization of endangered species populations. Long term: Recovery of key ecosystems and improved biodiversity.	N, E
Integration of Biodiversity Conservation into Agricultural Practices - Important to balance food production with biodiversity protection, particularly in rural areas of Bulgaria where agriculture is a dominant land use.	A, T	Short term: Reduced negative impacts of agriculture on biodiversity. Long term: Sustainable agricultural practices that support biodiversity.	R, N
Climate Change Adaptation for Mountain Ecosystems - Urgent due to the vulnerability of mountain regions in Bulgaria to climate change, which threatens unique habitats and species.	S, A	Short term: Enhanced resilience of mountain ecosystems to climate variability. Long term: Preservation of mountain biodiversity and ecosystem services.	R, N, E
Urban Green Infrastructure Development - Important for improving urban resilience to climate change while enhancing biodiversity in cities. Urban areas in Bulgaria face increasing pressures from urbanization and climate impacts.	A, T	Short term: Increased green space and biodiversity in urban areas. Long term: Resilient urban ecosystems that support human well-being and biodiversity.	R, N
Enhancing Cross-Border Environmental Cooperation - Urgent to address shared environmental challenges such as water pollution, biodiversity loss, and climate impacts in the Danube region through collaborative research and policy alignment. (Interreg Europe / EUSDR)	S, A	Short term: Improved cross-border coordination in environmental management and pollution control. Long term: A resilient and sustainable Danube region with enhanced environmental quality and biodiversity.	R, E

Sustainable Forest Management and Reforestation - Urgent due to deforestation and forest degradation in Bulgaria, which impact biodiversity and contribute to climate change.	S, A	Short term: Stabilization of forest ecosystems and reduction of deforestation rates. Long term: Restoration of forest ecosystems, enhanced carbon sequestration, and biodiversity conservation.	N, E
Development of Nature-based Solutions for Climate Mitigation and Adaptation - Important to leverage natural processes to address climate challenges, which is increasingly recognized as a cost-effective and sustainable approach.	A, T	Short term: Implementation of pilot projects showcasing the effectiveness of nature-based solutions. Long term: Widespread adoption of nature-based solutions that enhance climate resilience and biodiversity.	N, E, I
Monitoring and Management of Invasive Species - Urgent to control and mitigate the impact of invasive species on native biodiversity in Bulgaria, which poses a significant threat to ecosystems.	S, A	Short term: Reduction in the spread and impact of invasive species. Long term: Protection of native species and ecosystems from invasive threats.	N, E
Public Awareness and Education on Biodiversity and Climate Change - Important to increase public understanding and engagement, which is essential for the successful implementation of conservation and climate strategies.	T, A	Short term: Increased public awareness and involvement in conservation activities. Long term: A well-informed society that actively participates in biodiversity and climate protection efforts.	R, N, E
Policy Development for Biodiversity Conservation and Climate Resilience - Urgent to create and enforce policies that effectively address biodiversity loss and climate impacts, ensuring long-term sustainability.	S, T	Short term: Strengthened legal frameworks and policy enforcement. Long term: Comprehensive policies that protect biodiversity and promote climate resilience.	N, E
Sustainable Tourism and Biodiversity Protection - Important to balance economic benefits from tourism with the need to protect natural habitats, especially in Bulgaria's national parks and protected areas.	A, T	Short term: Implementation of sustainable tourism practices. Long term: Preservation of natural areas while supporting local economies through responsible tourism.	R, N, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

3.1.4 Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Smart City Technologies and Digitalization of Urban Services - Urgent to improve the efficiency, sustainability, and livability of urban areas in Bulgaria through the integration of digital technologies.	A, T	Short term: Improved public service delivery and enhanced urban management. Long term: Fully integrated smart cities with data-driven governance and high quality of life.	R, N, E
Green Infrastructure and Urban Greening - Important for enhancing urban resilience to climate change, improving air quality, and increasing biodiversity in urban environments.	S, A	Short term: Increased green spaces and improved urban microclimates. Long term: Sustainable urban ecosystems that support biodiversity and provide ecosystem services.	R, N
Sustainable Urban Mobility and Public Transport - Urgent to reduce traffic congestion, lower emissions, and improve accessibility in urban areas. This is critical for achieving climate goals and enhancing urban living standards.	A, T	Short term: Reduced traffic congestion and emissions, improved public transport systems. Long term: Sustainable, efficient, and low-emission urban mobility networks.	R, N, E
Energy Efficiency in Urban Buildings and Infrastructure - Important to lower energy consumption, reduce greenhouse gas emissions, and meet European energy targets.	S, A	Short term: Improved energy efficiency in urban infrastructure and buildings. Long term: Energy-efficient cities with reduced carbon footprints and lower operational costs.	N, E
Climate Adaptation and Resilience in Urban Planning - Important to ensure that cities are prepared for and resilient to the impacts of climate change, including extreme weather events.	S, A	Short term: Increased urban resilience to climate impacts. Long term: Cities that are adaptable and resilient to long-term climate changes, safeguarding communities and infrastructure.	N, E
Social Equity in Urban Development - Important to ensure that urbanization benefits all residents, particularly vulnerable populations, and that development is socially inclusive.	T, A	Short term: Reduced inequality in urban areas, improved access to services for all residents. Long term: Socially inclusive cities where all residents benefit from urban development and economic growth.	N, E, I

Enhancing Cross-Border Environmental Cooperation - Urgent to address shared environmental challenges such as water pollution, biodiversity loss, and climate impacts in the Danube region through collaborative research and policy alignment. (Interreg Europe / EUSDR)	S, A	Short term: Improved cross-border coordination in environmental management and pollution control. Long term: A resilient and sustainable Danube region with enhanced environmental quality and biodiversity.	R, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

3.1.5 Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Cross-Border Energy Collaboration in the Balkans - Important to enhance regional energy security and cooperation, particularly in integrating renewable energy sources across borders.	S, A	Short term: Improved regional energy interconnections and collaboration on renewable projects. Long term: A highly integrated and resilient regional energy network supporting sustainable energy transition.	R, N, E
Innovation in Low-Carbon Technologies - Urgent to develop and deploy next-generation technologies that can drive the energy transition more effectively.	S, A	Short term: Development and testing of low-carbon technologies. Long term: Widespread adoption of innovative technologies that significantly reduce carbon emissions and enhance energy sustainability.	N, E, I
Public Engagement and Education on Sustainable Energy - Important to build public support and understanding of the energy transition, which is essential for its successful implementation.	T, A	Short term: Increased public awareness and participation in energy-saving practices. Long term: A well-informed and engaged society that actively supports and participates in the energy transition.	R, N
Policy and Regulatory Frameworks for Sustainable Energy Transition - Urgent to create the necessary legal and regulatory conditions to support the rapid deployment of renewable energy and energy efficiency measures.	S, T	Short term: Implementation of supportive policies and incentives for renewable energy. Long term: A stable and predictable regulatory environment that encourages investment in sustainable energy.	N, E
Energy Efficiency in Buildings and Infrastructure - Important for reducing energy demand, lowering emissions, and achieving sustainable urban development.	A, T	Short term: Reduced energy consumption in buildings, improved insulation and energy systems. Long term: Highly energy-efficient urban environments with minimal carbon footprints.	R, N

Development of Green Hydrogen Technologies - Urgent for decarbonizing sectors that are hard to electrify, such as heavy industry and transport. This is key for achieving deep decarbonization.	S, A	Short term: Pilot projects and scaling up green hydrogen production. Long term: Widespread adoption of green hydrogen in industrial processes and transport, contributing to significant emission reductions.	N, E, I
Enhancing Cross-Border Environmental Cooperation - Urgent to address shared environmental challenges such as water pollution, biodiversity loss, and climate impacts in the Danube region through collaborative research and policy alignment. (Interreg Europe / EUSDR)	S, A	Short term: Improved cross-border coordination in environmental management and pollution control. Long term: A resilient and sustainable Danube region with enhanced environmental quality and biodiversity.	R, E
Energy Storage Solutions and Smart Grid Development - Important to address the intermittent nature of renewable energy sources and enhance grid resilience and efficiency.	S, A	Short term: Improved energy storage capacity, enhanced grid management. Long term: A stable, resilient, and efficient energy system that can accommodate high levels of renewable energy.	N, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

3.1.6 Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Enhancing Cross-Border Environmental Cooperation - Urgent to address shared environmental challenges such as water pollution, biodiversity loss, and climate impacts in the Danube region through collaborative research and policy alignment. (Interreg Europe / EUSDR)	S, A	Short term: Improved cross-border coordination in environmental management and pollution control. Long term: A resilient and sustainable Danube region with enhanced environmental quality and biodiversity.	R, E
Sustainable Economic Development in the Danube Region - Important to promote sustainable economic activities that balance growth with environmental protection, particularly in sectors like agriculture, tourism, and energy. (EUSDR)	A, T	Short term: Development of sustainable business models and practices. Long term: Economic growth that aligns with environmental sustainability, ensuring long-term prosperity for the region.	R, N, E

Resilient Infrastructure Development in the Danube Region - Important to enhance the resilience of infrastructure against climate change impacts, such as flooding, which are prevalent in the Danube basin. (EUSDR)	S, A	Short term: Improved resilience and adaptation of critical infrastructure. Long term: Climate-resilient infrastructure that supports sustainable development and reduces vulnerability to climate-related risks.	R, E
Biodiversity Conservation in the Danube Delta - Urgent to protect and restore the unique ecosystems of the Danube Delta, which are under threat from human activity and climate change. (EUSDR)	S, A	Short term: Improved conservation efforts and habitat restoration. Long term: A preserved and resilient Danube Delta ecosystem that supports biodiversity and sustains local communities.	R, E
Strengthening Innovation Ecosystems - Urgent to enhance Bulgaria's innovation capacity by fostering collaboration between research institutions, industry, and government. This is crucial for driving economic growth and technological advancement. (National Innovation Strategy / Interreg Europe)	S, T	Short term: Improved collaboration and knowledge transfer among innovation stakeholders. Long term: A robust innovation ecosystem that drives sustained economic growth and global competitiveness.	N, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

3.2 Promising funding schemes

Among the collaborative funding schemes that were identified, Horizon Europe, Interreg Europe, and the LIFE Programme are seen as the most effective in terms of knowledge production and dissemination. Horizon Europe is particularly effective because it supports large-scale collaborative projects that span multiple disciplines and sectors, fostering cross-border cooperation and the integration of diverse expertise. This broad collaboration leads to high-quality knowledge production and the development of innovative solutions. The programme places a strong emphasis on the dissemination of research results, requiring projects to have comprehensive communication and exploitation strategies. It supports projects that involve multiple partners from different countries and sectors, promoting the exchange of knowledge and best practices. With substantial financial resources, Horizon Europe can support ambitious projects that have the potential to make a significant impact. Interreg Europe is designed to facilitate cooperation between European regions, enabling them to share experiences and learn from each other. This programme is particularly effective in knowledge production because it promotes the exchange of best practices and innovative solutions to common regional challenges, such as sustainable development and cultural heritage preservation. It also emphasizes the dissemination of successful regional policies and practices across the EU, making it a valuable tool for scaling up local innovations and adapting them to different contexts. The LIFE Programme is highly effective in knowledge production because it supports on-the-ground projects that generate practical insights into environmental conservation and climate adaptation. The programme is particularly known for its focus on replicability and scalability, encouraging projects to develop models and best practices that can be applied elsewhere. Dissemination is a core component with funded projects required to actively share their results through various channels, including workshops, publications, and online platforms. This ensures that the knowledge generated has a wide reach and contributes to broader environmental and climate goals.

One of the most significant challenges is the limited funding available for research and development in general. This impacts the capacity of institutions like BAS, and universities to conduct much research, engage in policy advocacy, and implement projects that bridge science and practice. Increasing public investment in R&D is crucial. Bulgaria could also explore alternative funding mechanisms, such as public-private partnerships, crowdfunding, and international grants. Encouraging more private sector investment in research could also alleviate funding shortages.

The following thematic areas are poorly or not adequately covered by current funding schemes or organizations: Biodiversity-Compatible Renewable Energy Projects, Public Engagement and Education on Sustainable Energy, Circular Economy in Energy Systems, Cross-Border Energy Collaboration in the Balkans. These thematic areas represent significant gaps in current funding schemes that need to be addressed to ensure a holistic and equitable approach to sustainability, biodiversity conservation, and energy transition. While there is strong support for renewable energy transition (e.g., Horizon Europe, LIFE Programme), in Biodiversity-Compatible Renewable Energy Projects there is less focus on ensuring that renewable energy projects are developed in ways that are compatible with biodiversity conservation. Current funding schemes often emphasize the expansion of renewable energy capacity without sufficiently addressing the potential ecological impacts of such projects, particularly in sensitive habitats. Although public engagement is recognized as important, there is limited funding specifically dedicated to educating and engaging the public on the energy transition and sustainability practices. Most current schemes focus on technological

innovation and infrastructure rather than the social and behavioural aspects of the energy transition. While there is some regional collaboration supported through Interreg Europe, there is a limited focus on cross-border energy collaboration specifically tailored to the Balkans, where energy security and integration of renewable energy sources across borders are crucial. Current funding schemes do not fully address the unique challenges and opportunities in this region.

Regional, cross-border collaboration among Bulgaria and its direct neighbours should indeed be prioritized in specific contexts, such as addressing shared environmental and energy challenges in regions like the Balkans and the Danube Basin. These collaborations are often more focused, leveraging geographical, cultural, and resource similarities for targeted solutions. However, EU-level collaboration remains critical for accessing broader funding, innovation networks, and policy frameworks, which can amplify the impact of regional efforts. Therefore, the prioritization should be context-dependent, ensuring that regional initiatives complement and align with broader EU objectives for maximum effectiveness.

For the CASRI SRIA, it is important to stress how participation in CASRI can enhance national and regional competitiveness by positioning the country as a leader in sustainability research and innovation. This can attract further investment, foster innovation, and create new economic opportunities. Also, highlight the risk-sharing benefits of participating in a cross-national scheme. By pooling risks with other countries, national funders can support more ambitious projects with potentially higher returns without bearing the full burden of risk. Emphasize the value of collaborative innovation and the exchange of best practices facilitated by CASRI. National funders can benefit from being part of a network that fosters continuous learning and adaptation based on the successes and challenges of other countries. For example: countries like Germany and Denmark have implemented advanced technologies and policies in energy-efficient building design and renewable energy integration. Bulgaria could adapt these practices to modernize its building stock and reduce energy consumption, particularly in public housing and municipal infrastructure. This could involve collaboration with organizations such as the Bulgarian Energy Efficiency and Renewable Sources Fund (EERSF) and local municipalities.

The Netherlands and Switzerland offer excellent examples of incorporating biodiversity into urban and rural planning, such as green roofs, wildlife corridors, and ecosystem restoration projects. Bulgaria could apply these concepts in areas like the Danube Basin, where maintaining ecological balance is crucial, and in urban settings like Sofia or Plovdiv. Coordination with Bulgarian entities like the Ministry of Environment and Water and NGOs such as the Bulgarian Biodiversity Foundation would be essential.

Bulgaria's rich cultural and architectural heritage, including its historic towns and rural villages, requires that energy efficiency upgrades and biodiversity projects respect traditional aesthetics and building techniques. Building trust between government institutions, local authorities, and citizens is vital for implementing policies effectively. Learning from countries with strong governance in sustainability projects could help enhance this aspect in Bulgaria.

3.3 Improving the Science Practice Policy interface (SPPI)

Bulgarian universities and research institutes, particularly those affiliated with the Bulgarian Academy of Sciences (BAS), are central to the country's scientific output. These institutions conduct research that can inform policy, especially in areas like environmental science, public health, and technology. We have Governmental Advisory Bodies that are specialized advisory bodies and expert councils within the government that include scientists and researchers. These bodies contribute to policy formulation by providing scientific expertise and evidence-based recommendations. However, the influence of these bodies can be variable, depending on the political context and the specific issue at hand. The translation of scientific research into policy is sometimes hampered by a lack of structured mechanisms for integrating scientific evidence into decision-making. Policy formulation may also be influenced by political priorities, economic constraints, and societal pressures, which can lead to a gap between scientific advice and actual policy. The mechanisms that could help bridge the gap between scientific research and policy formulation could include structured platforms or frameworks where scientists, policymakers, and stakeholders regularly interact. Examples include advisory councils, task forces, or think tanks focused on translating scientific findings into actionable policy recommendations.

Dedicated Science Advisors or Units are another important thing. Embedding science advisors within government ministries or establishing dedicated units responsible for analysing and presenting scientific evidence tailored to policy needs.

There are efforts to bridge the gap between scientific research and practical application, particularly through technology transfer offices and innovation hubs. These initiatives aim to commercialize research findings and promote collaboration between academia and industry. BAS serves as a key generator of scientific knowledge and innovation in Bulgaria. It conducts foundational and applied research that can be translated into practical applications, especially in areas like environmental protection, biotechnology, and materials science. Technology transfer offices and innovation hubs rely on the research output from institutions like BAS to identify commercially viable technologies or solutions.

Established in 2005 and restructured in 2010, the Joint Innovation Centre (JiC) of BAS serves as a coordination unit for implementing BAS's policies in innovation and patent activities. It provides information on EU funding opportunities, supports project preparation and implementation, and fosters business contacts both domestically and internationally. JiC is also a partner in the Enterprise Europe Network, assisting in the development of innovation potential.

The Aerospace Technology Transfer Center at the Space Research and Technology Institute (SRTI-BAS) aims to shorten the transition from innovation to production in aerospace technologies. It is integrated into a network of similar centers across Europe and the world, promoting the transfer of aerospace innovations to the economy. However, challenges such as limited funding, bureaucratic hurdles, and a small market size can impede progress. In areas like environmental protection and public health, scientific research plays a crucial role in shaping practices, for instance, research on air quality, water resources, and biodiversity informs environmental management practices, while epidemiological studies guide public health interventions. Nonetheless, the implementation of scientifically informed practices can be inconsistent, due to factors like limited resources, governance issues, and public awareness.

The Bulgarian education system includes vocational and higher education programs that aim to translate scientific knowledge into practical skills. However, there is often a mismatch between the skills provided by educational institutions and the needs of the labour market, which affects the practical application of scientific knowledge.

Overall, while there are significant efforts to align science, policy, and practice in Bulgaria, challenges such as limited resources, administrative hurdles, and varying levels of public and political support can affect the effectiveness of these interactions. However, ongoing EU integration and collaboration with international partners provide opportunities for strengthening these connections.

The Bulgarian Academy of Sciences is the leading national research organization in Bulgaria. It encompasses a wide range of scientific disciplines and plays a crucial role in providing scientific expertise to the government and other stakeholders. BAS regularly conducts research that informs policy decisions in various fields, including environmental protection, public health, and technology. They also engage in public outreach and educational activities to communicate scientific findings to broader audiences. BAS provides expert opinions, participates in governmental advisory councils, and collaborates with both national and international organizations to ensure that scientific research is reflected in policy and practice.

The role of regulatory bodies like the EPA tend to focus on policy enforcement, monitoring, and compliance, whereas BAS emphasizes research, innovation, and advisory services. The EPA focuses primarily on implementing national and EU environmental policies. This includes enforcing regulations, monitoring environmental indicators (e.g., air and water quality, waste management), and ensuring compliance with environmental standards. Unlike BAS, which generates foundational and applied scientific research, the EPA uses this research as a basis to enforce policies and regulations. The EPA is responsible for the collection, analysis, and reporting of environmental data. It feeds into national and international reporting obligations, such as under the EU Green Deal and the United Nations Frameworks on Climate Change and Biodiversity. BAS contributes to the scientific methodologies and technologies that the EPA might employ for this monitoring. Both are critical to bridging the gap between science and practical application, but their focus areas are distinct and complementary. Ensuring seamless collaboration between these entities is essential for the success of CASRI initiatives across all themes.

Bureaucracy and administrative inefficiencies often slow down the implementation of research projects and the translation of scientific findings into policy and practice. This includes delays in funding disbursement, complex regulatory frameworks, and cumbersome approval processes. Although there are advisory bodies and councils, the integration of scientific research into policymaking is often inconsistent. This is partly due to the lack of structured mechanisms for ensuring that scientific evidence is systematically considered in decision-making processes. Public engagement with science is relatively low in Bulgaria, which can hinder the translation of scientific knowledge into practice. This includes a lack of awareness about the importance of science, scepticism towards scientific findings, and limited public input into science-related policies.

While Bulgaria has several active organizations and initiatives that facilitate the interaction between science, policy, and practice, there are clear areas where improvement is needed. Addressing these challenges requires not only increased funding and streamlined processes but also the development of new structures and activities that can better integrate scientific knowledge into policy-making and practical applications.

Strengthening collaboration, enhancing science communication, and fostering public engagement are critical steps toward achieving a more effective science-policy-practice nexus in Bulgaria.

To strengthen the science-policy-practice nexus in Bulgaria, new structures and activities could be introduced to better integrate scientific knowledge into policy-making and practical applications. Examples include: National Science-Policy Interface Platform (a dedicated platform where scientists, policymakers, and practitioners collaborate on pressing national issues); Regional Science Hubs; Innovation-Policy Coordination Office (a centralized body linking research institutions, industry, and government. This office would identify research with high policy relevance, facilitate joint projects, and promote technology transfer); Policy Co-Design Workshops (Interactive sessions where scientists, policymakers, and stakeholders collaborate to develop policies informed by scientific evidence).

3.4 Recommendations for CASRI by NKS

Based on both the interviews and the workshop:

Points of attention

- Design training programs that address the specific needs of various stakeholder groups, including early-career researchers, experienced policymakers, and industry leaders.
    - Ensure that training is customized to equip participants with relevant skills and knowledge that they can immediately apply in their professional contexts.
    - Include essential soft skills such as negotiation, conflict resolution, and leadership in capacity-building programs.
    - Recognize that interdisciplinary work and science-policy interactions require the ability to navigate diverse perspectives and interests, making soft skills crucial for effective collaboration and decision-making.
- Establish mechanisms for ongoing monitoring and feedback to assess the impact of research on policy and practice.
- Use continuous evaluation to refine approaches based on lessons learned, ensuring that strategies remain adaptable and the science-policy interface stays dynamic and responsive to new challenges.
- Explore diverse funding mechanisms, including public-private partnerships, international grants (e.g., Horizon Europe, LIFE), and private sector engagement in R&D.
- Introduce transparent and efficient funding disbursement processes to reduce delays and enable timely project execution.
- Address the variability in the influence of advisory bodies by ensuring their recommendations are formally considered in decision-making processes.
- Enhance collaboration between educational institutions, BAS, and industry to develop curricula that reflect emerging trends in sustainability and innovation.

Recommendations

- Establish formal networks that connect researchers from various disciplines with policymakers, industry leaders, and civil society representatives. These networks should facilitate regular interaction, knowledge exchange, and collaborative project development.

- Design funding schemes that specifically reward interdisciplinary collaboration. These schemes could include larger grants for projects that successfully integrate multiple fields and demonstrate potential for broad societal impact.
- Fund pilot projects that explore innovative interdisciplinary approaches to sustainability challenges. Successful pilots could be scaled up with additional funding and support, serving as models for future projects.
- Introduce a certification program for professionals who complete training in key areas such as policy analysis, science communication, and stakeholder engagement. This could enhance the credentials of participants and encourage broader participation.
- Utilize digital platforms to deliver training programs, making them accessible to a global audience. Incorporate interactive elements such as webinars, online discussions, and virtual workshops to enhance engagement.
- Regularly produce and distribute policy briefs that synthesize research findings relevant to current policy debates. These briefs should be concise, accessible, and co-produced with policymakers to ensure they meet their needs.
- Organize regular policy dialogues where researchers and policymakers can discuss emerging issues and explore how research can inform policy development. These dialogues should be structured to promote mutual understanding and collaboration.
- Develop and deploy tools to assess the impact of research on policy outcomes. These tools should track how research influences policy decisions, identify barriers to implementation, and provide feedback to improve future research agendas.
- Align vocational and higher education programs with labour market needs to ensure practical application of scientific knowledge.
- Increase public investment in research and development (R&D) to enhance the capacity of institutions like BAS and universities to conduct impactful research and bridge the gap between science and policy.
- Simplify administrative and regulatory frameworks to facilitate faster implementation of research projects and the integration of scientific findings into policy.

3.5 Reflection on the workflow

The collected information is representative, as the interviews included participants from academia, business, non-governmental organizations, and ministries, ensuring a diversity of perspectives. However, the number of interviewees was not large, which limits the depth and scope of the analysis. Conducting more extensive interviews would likely yield more diverse and comprehensive results, enriching the conclusions.

One of the weaknesses of the questionnaire used was its length. In today's fast-paced environment, people often lack the patience and time to focus on long and sometimes repetitive questions, even when they address the four main topics of the project. This made the interviewing process lengthy and somewhat burdensome for both interviewees and interviewers.

At the workshop, however, the discussions were more spontaneous, and the topics naturally flowed into one another. This created a dynamic and productive atmosphere that encouraged the exchange of ideas and information. The Botanical Garden of the Bulgarian Academy of Sciences turned out to be a wonderful venue for holding these meetings. We believe that organizing more workshops would be particularly beneficial, as these forums allow stakeholders to meet directly, discuss important issues, and build partnerships.

If I had to execute the workflow again, I would extend the workshop duration, even though it was already two days, to allow more space for in-depth discussions. I would also organize additional workshops with specific presentations and proposals for solutions to key issues. It is also crucial to set clear expectations for participants—what can be achieved through the work on CASRI and to what extent the project can influence decision-makers. This would foster participant engagement and make the process more focused and effective.

4 FINLAND – National Report

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SUMMARY IN FINNISH

Ympäristö- ja kestävyystutkimusta ja innovointia ei Suomessa koordinoida kansallisen tason kokoavan strategian tai ohjelman tasolla. Sen sijaan tutkimusta ja innovointia pyritään ohjaamaan teema- tai sektorikohtaisesti. Tämä luo mahdollisuuksia olemassa olevien tutkimuksen vahvojen alojen kehittämiselle ja aiemmasta tiedontuotannosta kumpuavalle innovoinnille, mutta luo samalla riskin polkuriippuvuuksista, joissa ei tunnisteta riittävän hyvin uudenlaisia sektorit ylittäviä haasteita ja mahdollisuuksia. Haasteena on myös osaoptimointi, jonka avulla ei saada aikaan riittävän nopeaa ja laaja-alaista kestävyysmurrosta. Tämä on ongelmallista erityisesti siksi, kokonaisuudessaan luonnonvarojen kulutus ja ympäristön kuormitus Suomessa on liian suurta.

Suomen nykyisenä yleisenä tiedepoliittisena tavoitteena on nostaa tutkimus- ja kehittämistoiminnan osuus bruttokansantuotteesta neljään prosenttiin, josta 1,2 prosenttia on peräisin julkisesta rahoituksesta ja 2,8 prosenttia yksityisestä rahoituksesta. Ympäristö- ja kestävyyskysymykset ovat mukana monissa tutkimusohjelmissa, strategioissa ja linjauksissa, mutta ekologiset ja sosiaaliset tavoitteet jäävät tyypillisesti alisteisiksi taloudellisen kasvun tavoittelulle. Ympäristön ja luonnonvarojen rajallisuuden vakavasti ottava vahvan kestävyyden näkökulma ei ohjaa suomalaista tutkimus- ja innovaatiopolitiikkaa. Sen sijaan tavoitteenasettelussa painottuu heikko kestävyys ja niin sanottu kokonaiskestävyys, mikä käytännössä mahdollistaa ympäristöllisistä ja sosiaalisista tavoitteista tinkimisen lyhyen aikavälin taloudellista hyötyä tavoiteltaessa.

Eri kestävyystavoitteita integroivaa kestävän kehityksen politiikkaa on Suomessa edistetty kansainvälisesti vertaillen pitkäjänteisesti, tietoperustaisesti ja eri tahoja osallistavasti. Suomi on ollut eturintamassa esimerkiksi YK:n 17 kestävän kehityksen globaalin tavoitteen raportoinnissa. Kestävän kehityksen politiikan täytäntöönpanon resursointi on kuitenkin ollut vaatimatonta ja yhteiskunnallinen vaikuttavuus riittämätöntä. Sen kyky ohjata tutkimusta, kehittämistä ja innovointia laaja-alaisesti muilla sektoreilla on jäänyt erittäin vähäiseksi.

CASRI-hankkeessa tunnistettiin keskeisiä tutkimuksen ja innovoinnin kysymyksiä kirjallisuuskatsauksen, asiantuntijahaastatteluiden ja -työpajan perusteella. CASRI-hankkeen lähtökohtana olleiden neljän tutkimusteeman osalta keskeisiksi aihepiireiksi nousivat seuraavat:

- *Resilientit nettonollapäästöiset kiertotalouden tuotantosysteemit.*
  Kiertotalouden konkreettinen toteuttaminen erityisesti edistämällä uusien liiketoimintamallien digitaalisia ratkaisuja sekä metsäsektorin biokiertotaloutta.
- *Biodiversiteetti ja ilmasto:*
  Luonnon monimuotoisuuden tutkiminen talousjärjestelmän kontekstissa, erityisesti ekosysteemien resilienssin ja sosio-ekologisten muutoskyvykkyyksien tutkimus.
- *Kestävä kaupungistuminen.*
  Kestävyysmurrosta tukevan paikallisen demokratian ja osallistumisen kehittäminen, erityisesti innostavien ja konkreettisten kestävyyden visioiden luontiin ja niiden toimeenpanoon liittyvä tutkimus.
- *Luonto- ja ympäristöystävällinen energiamurros:*
  Energiamurroksen positiiviset ja negatiiviset ympäristövaikutukset, uudet energiantuotantotavat ja niiden sosiaaliset ja kulttuuriset kytkennät.

Näiden neljän ennalta määritellyn teeman rinnalla haastatteluissa ja työpajassa painottuivat lukuisat muut kysymykset, joista keskeisimmäksi nousi neljää teemaa yhdistävä luonnonvarojen ylikulutukseen liittyvä tutkimus. Lisäksi korostui tarve erilaisille systeemisille lähestymistavoille, jotka auttavat tarttumaan erilaisiin kestävyyskysymyksiin samanaikaisesti. Tarvitaan kattavampaa ympäristö- ja yhteiskunnallisten vaikutusten seurantaa koko elinkaaren ajan tuotteille, palveluille ja prosesseille. Tämä sisältää niin suorien kuin epäsuorien vaikutusten sekä pitkäaikaisten seurausten huomioimisen. Lisäksi on keskeistä kehittää ja ottaa käyttöön tehokkaita työkaluja ja menetelmiä kestävyyden arvioimiseksi eri sektoreilla ja skaaloilla.

Haastatteluissa ja työpajassa ilmeni näkemysten jakautuneisuus tiedon yhteiskunnallisen hyödyntämisen, tiedeviestinnän ja vuorovaikutuksen nykytilasta Suomessa. Yhtäältä tiedonkulku ja vuorovaikutus eri toimijoiden välillä nähtiin sujuvaksi suomalaisessa matalien hierarkioiden, toimivien verkostojen ja hyvän koulutustason keskustelukulttuurissa. Toisaalta varsinkin viimeaikaisen keskustelun haasteena pidettiin yleistä polarisoitumista, jota sosiaalisen median toimintalogiikka korostaa, tutkimusperustaisen tiedon sivuuttamista päätöksenteossa sekä joidenkin toimijoiden suoranaista tiedevastaisuutta. Myös valtioneuvoston yhteisen tutkimus- ja selvitystoiminnan lakkauttamista pidettiin negatiivisena kehityksenä. Uskottavuuden ja riippumattomuuden säilyttämisen haasteet nousivat esiin tutkijoiden ja politiikan vuorovaikutuksessa. Välittävien organisaatioiden ja verkostojen, kuten tietoa kokoavien ja itsenäisesti toimivien tiedepaneelien, merkitystä pidettiin tärkeänä. Strategisen tutkimuksen neuvoston rahoittamat monitieteiset, pitkäjänteiset ja vuorovaikutukseen panostavia hankkeet mainittiin hyvänä esimerkkinä kestävyystutkimuksen toteuttamistavasta.

Ympäristö- ja kestävyystutkimusta ja innovointia laaja-alaisesti suuntaavaan uuden toimintaohjelman muotoilussa tärkeänä lähtökohtana pidettiin eri toimijoiden vuoropuhelua tutkimusprioriteettien määrittelyssä ja sen varmistamista, että innovoinnissa kyetään vastaamaan keskeisiin kestävyyshaasteisiin. Lisäksi korostettiin mitattavissa olevien tavoitteiden tärkeyttä, pitkäjänteisen kestävyystutkimuksen ja nopeasti muuttuvien olosuhteiden yhteensovittamista sekä kestävyystieteen normatiivisten lähtökohtien huomiointia. Näiden taustalla on kestävyystieteen kokonaisvaltainen yhteiskunnallinen tarkastelu.

Ympäristö- ja kestävyystutkimuksen ja innovoinnin yhteisrahoituksen kehittämisessä tärkeänä pidettiin rahoittajien sopivaa määrää, joka mahdollistaa sekä riittävän suuren rahoituksen määrän että minimoi hallinnollisen taakan ja mahdollistaa eri rahoittajien kiinnostuksen kohteiden sujuvan yhteensovittamisen.

EXECUTIVE SUMMARY ENGLISH

Environment and sustainability research and innovation are not coordinated in Finland at a national level through a comprehensive strategy or program. Instead, research and innovation are aimed to be directed thematically or sector wise. This creates opportunities for developing existing strong areas of research and innovation emerging from previous knowledge production, but it also creates a risk of path dependence, where new, cross-sectoral challenges and opportunities are not sufficiently recognized. A challenge is also the lack of system optimization, which does not lead to a fast enough and comprehensive sustainability transition. This is problematic particularly because Finland's overall consumption of natural resources and environmental burden is too high.

Finland's current national science policy goal is to raise the share of research and development in gross domestic product to four percent, of which 1.2 percent comes from public funding and 2.8 percent from private funding. Environmental and sustainability issues are included in many research programs, strategies and guidelines, but ecological and social goals typically remain subordinate to the pursuit of economic growth. A strong sustainability perspective that seriously takes into account the limitations of the environment and natural resources does not guide Finnish research and innovation policy. Instead, the activities are based on the conception of weak sustainability, emphasising attempts to secure short term economic development potentially sidelining environmental and social goals.

Finland has consistently promoted a sustainable development policy that integrates different sustainability goals. It has been based on evidence, and it actively involves various stakeholders. Finland has been at the forefront in reporting progress towards the UN's 17 Sustainable Development Goals, for example. However, the funding allocated for implementing sustainable development policies has been insufficient, and its overall societal impact remains limited. Its capacity to guide research, development, and innovation across a wider range of sectors has been extremely weak.

CASRI project identified key priorities for research and innovation based on literature and document analysis, expert interviews and a workshop. The key priorities under the four predefined CASRI themes were the following:

- Resilient Net-Zero Emission Circular Economy Production Systems
  Concrete implementation of circular economy, especially by promoting new digital business models and developing forest sector circular bioeconomy.
- Biodiversity and Climate
  Biodiversity research in a context of the economic system, especially research focusing on ecosystem resilience and socio-ecological capacities for change and adaptation.
- Sustainable Urbanisation
  Developing local democracy and participatory processes that support sustainability transitions. Especially studies focusing on the creation and implementation of inspiring and tangible visions for sustainability in urban environments.
- Nature- and Environment-Friendly Energy Transition
  Assessing both positive and negative environmental impacts of energy transition. Exploring the societal and cultural implications of new energy technologies.

Alongside these four pre-defined themes, numerous other questions emerged during interviews and workshop, the most important of which was the need for systemic approaches to tackle overconsumption of natural resources. This helps to address different sustainability issues simultaneously and emphasizes the interconnectedness of various environmental, social, and economic factors.

In addition, there is a need for more comprehensive monitoring of environmental and social impacts throughout the entire lifecycle of products, services and processes. This includes considering both direct and indirect impacts, as well as long-term consequences. Furthermore, it is crucial to develop and implement effective tools and methods for assessing sustainability performance across different sectors and scales.

Interviews and the workshop revealed a divided view on the state of societal utilization of knowledge, science communication, and interaction in Finland. On one hand, information flow and interaction between different actors are seen as smooth due to Finland's low hierarchical structures, functioning networks, and strong educational background. However, on the other hand, challenges were identified with polarization in recent discussions, which social media dynamics amplify, the marginalization of research-based knowledge in decision-making processes, and even outright science denial by certain actors. The discontinuation of the joint mechanism for Government's analysis, assessment and research activities was also seen as a negative development.

Challenges related to maintaining trust as well as credibility and independence of researchers arose in the interaction between researchers and policymakers. The importance of intermediary organizations and networks, such as those that gather and disseminate information and independent science panels, was emphasized. Projects funded by the Strategic Research Council that are interdisciplinary, long-term, and emphasize interaction were highlighted as good examples of how sustainability research can be implemented.

"When designing a new program to promote broad-ranging environmental and sustainability research and innovation, open dialogue among stakeholders was seen as crucial for defining research priorities. It was also emphasized that innovations should effectively address key sustainability challenges. The importance of measurable goals, reconciling long-term sustainability research with rapidly changing circumstances, and integrating the normative foundations of sustainability science were also highlighted. This reflects a holistic societal perspective on sustainability science.

In developing joint funding for environmental and sustainability research and innovation, it was deemed important to have a suitable number of funders[8] that would allow both a sufficient amount of funding and minimize administrative burden while facilitating the alignment of different funders' interests.

[8] The optimal number of funders is highly dependent on both the availability of resources and the focus of R&I ambitions. In narrowly focused cases, collaboration between two or three funders can be fruitful, while in cases tackling larger sustainability challenges, pooling resources from a larger group of funders is a necessity.

4.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

4.1.1 National research context

Our desk study and interview round did not identify any single national research and innovation agenda that coordinates or comprehensively encompasses all the predefined CASRI themes of research and innovation (R&I) in Finland. The multiannual plan for the use of central government research and development funding (Valtioneuvosto 2024) outlines the general level targets for R&I spending but does not specify any priority areas. The national R&I agenda aims for increasing the R&I funding to a level of 4% share of the GDP (with 1.2% originating from public spending and 2.8 from private sources). It does not specify any goals related to sustainability or other substance areas. Instead, priority areas are outlined in various sector-based strategies, operational programmes and other targeted initiatives. For example, biotechnologies and information technologies have been highlighted as Finnish priority areas during the past decades (Castells & Himanen 2001; Väliverronen 2007).

In Finland, responsibilities related to environmental protection are divided between ministries (Ministry of the Environment, Ministry of the Agriculture and Forestry), regional authorities (Centres for Economic Development, Transport and the Environment) and municipalities. Finland has no specific EPA (Environment Protection Agency) but the Finnish Environment Institute serves as the government research institute providing knowledge supporting the design and implementation of environmental measures and taking care of some regulatory task, especially related to water management. Ministries fund typically only minor R&I projects aimed to serve direct needs related to policy design and implementation. Domestic R&I funding provided by regional authorities is very limited but regional authorities allocate considerable funding from the European Social Fund and European Regional Development Fund. Only the biggest municipalities have possibilities to fund research. Overall, public funding for R&I originates mainly from the national level.

The key governmental funding bodies include the Research Council of Finland, operating under the Ministry of Education and Culture and focusing both basic and applied research, and Business Finland, operating under the Ministry of Employment and the Economy. Business Finland supports technologically and commercially oriented collaboration between business and academia. A noteworthy funder is also the Finnish Innovation Fund Sitra. It is an independent public foundation operating under the supervision of the Finnish Parliament, with a mission of collaborating with partners from different sectors to research, trial and implement bold new ideas that shape the future.

Among Finnish ministries, the Agriculture and Forestry Ministry is currently the only one that has literally outlined a research, development, and innovation agenda (MaF 2023). Other ministries typically have strategies that also include priorities for R&I activities focusing on or related to environmental or sustainability issues. E.g. the Ministry of the Environment's strategy outlines key objectives: achieving carbon neutrality, halting biodiversity loss and pollution, accelerating the green transition by mainstreaming circular economy and reducing natural resource consumption, strengthening ecosystems to support sustainable lifestyles, and guiding societal decision-making towards a green transition (Höijer & Lonkila 2024). It also aims to systematically conduct research, utilize findings, and disseminate knowledge while ensuring funding for sustainability goals within R&D networks by participating in them (Höijer & Lonkila 2024).

National sustainable development policy is a potentially relevant instrument for the implementation of SRIA focusing on sustainability. Finland has a long tradition of national sustainable development strategies, but their policy influence is still weak and their impact on the formation of R&D&I activities is marginal (Berg et al. 2019; Haila et al. 2023; Lepenies et al. 2023). The Finnish National Commission on Sustainable Development has published a national sustainable development strategy in 2022. It identifies six areas of change aimed at achieving the SDGs and UN Agenda 2030. These are: a sustainable energy system, an economy and work that promote well-being, sustainable consumption, education, competence, and sustainable lifestyles, well-being, health, and social inclusion, a food system that promotes well-being, and the use of forests, water, and land that enhances biodiversity (FNCSD 2022). The strategy also outlines practices for achieving the goals of these transformation areas.

Finland's research and innovation infrastructure can be considered as advanced in international comparisons, but challenges remain as R&D expenditures have decreased significantly in Finland during the 2010s, while they have been increased in key peer countries. At the same time, productivity and national output have grown only slightly. The key R&D challenges are identified as limited cross-sectoral collaboration, a shortage of companies conducting R&D activities and businesses within R&D-intensive industries, a lack of skilled personnel, and the distribution of skilled personnel across different sectors of society, as well as the concentration of top-tier research and expertise clusters on a few subject areas (Valtioneuvosto 2024, 38–39).

Sustainability issues have been included in societal goal setting such as the Government Programmes to a varying degree. The programme of Prime Minister Marin (2019-2023) put a great emphasis on climate change and highlighted sustainability as one core goal, but implementation of seriously suffered from the exceptional pressures created by the Covid-19 crisis and the full-scale invasion of Russia to Ukraine. The programme of Prime Minister Orpo (2023-2026) focuses on economic sustainability and gives only minimal attention to environmental issues. Recently, concerns over national security and economic development have dominated the policy debate, also influencing the formation of research priorities.

It can be concluded that in the Finnish context there is both a room and a need for a SRIA that would help to coordinate sustainability issues and initiatives. Such a SRIA would reduce the risk of focusing overly on single issue or perspective, support long-term integration, ensure identification of knowledge gaps. It would also increase the capacities to address sustainable development policy from a strong sustainability perspective instead of a weak sustainability perspective dominated by short term economic considerations.

4.1.2 Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Prioritised topic			
Concrete implementation of circular economy: hindrances and opportunities for already identified potential solutions for more efficient and wise resource use.	S,A	Clearly formulated and efficiently implemented policies and means of implementation, reduction of material demand (short term)	N,E
Other topics			
Research of carbon dioxide capture technologies	A	Eradication of carbon emissions, turning emissions into products with Power-to-X technologies (medium & long term)	N,I
Digital solutions for novel circular economy business models capable of challenging the current practices and production chains	S,T	Creation of new markets and added value from improved use, re-use, recovery of various materials (short term)	R,N,I
Forest sector's bio and circular economy	A	More versatile products from forestry, more efficient material use (short & medium term)	N
Utilization of industrial side streams and waste	A	Making current processes more efficient, mobilisation of new resources (short term)	R,N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

The workshop participants prioritised “concrete implementation of circular economy” as the most important topic. This topic includes also “digital solutions for business models” and “forest sector’s bio and circular economy” as areas of high importance in the Finnish context. Lack of viable business models for circular economy was emphasised. In particular, innovations related to forest sector were seen as important for Finland. Lack of incentives for developing new circular solutions challenging the current operation logic of extractive industries was considered as a factor hindering innovations. There is a need for further piloting and ensuring social learning based on experiments. National programs and funding guiding the development, encouraging networking among the disintegrated field and supporting innovation ecosystems were seen as important enabling factors. Path dependencies related to current business models and vested interests maintaining existing industrial structures were considered as key obstacles. Serious conflicts of interests between established and new actors were raised as an issue slowing down potential change. A regulatory threat thwarting innovations and caused by lack of ambitious, consistent and predictable long-term policy goals was noted. This was related to a lack of strong national research and industry program focusing on sustainability transition. Too much focus on material recycling instead of material savings and possibilities to limit overconsumption were also emphasised as obstacles for sustainable circular economy. Despite the several detailed research needs identified, circular economy was also considered as an already established research topic that has been funded and it might therefore lack novelty. It was noted that innovation funding has been mainly focused on the level of individual business rather than on the innovation ecosystem level, stressing the need to focus on networks rather than individual actors. A need to diversify actor base from private enterprises to other actors such as cities and policy makers was noted.

4.1.3 Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Prioritised topic			
Biodiversity research in the context of the economic system: business implications of biodiversity loss and biodiversity policies; development of methods for the valuation of ecosystems and their services and resilience	A,T	Halting the biodiversity loss, establishment of market-based mechanisms for just compensation for biodiversity preservation (medium & long term)	N,I
Other topics			
Measurement of biodiversity and state of the nature: understanding how much nature should be conserved, how much of the area can be exploited and how	S	Up-to-date knowledge of ecosystem changes and clear picture of the impacts of land use effectively guiding policy making, identification of firm-level indicators (short term)	N
Predicting how climate change will change weather conditions	S,A	Improved possibilities to address climate risks (short & medium term)	R,N
Global research of biodiversity hotspots and unknown species	S	More effective global policies based on better understanding of biodiversity changes (medium term)	I
Basic research of biodiversity and its connections to the and global (eco)system and climatic system	S	Better preparedness to interconnected risks, implementation of policies addressing ecological thresholds (medium term)	I
Social implications of biodiversity and biodiversity protection, incentives for action and non-action	A,S	More effective biodiversity policies (short term)	N
Research on adaptation to and preparedness for climate change at both national and local levels	A	Adequate risk preparedness (short to long term)	R,N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

Overall, the topic of biodiversity and climate was perceived as extremely wide and overlapping with other themes.

Risk of decreased funding for comprehensive and long-term monitoring was noted. Workshop participants identified biodiversity research in the context of the economic system as a top priority, with emphasis on ecosystem resilience and adaptation to change. For example, how much saving can be generated by maintaining the resilience in a changing climate? Research focusing on the economic value of nature was seen important for policymakers.

Biodiversity solutions are not seen as business opportunities and there are clashes with dominant R&D policy goals. Climate effects are starting to be monetized and integrated in businesses, but biodiversity is lagging by decades. In particular, monitoring and concrete indicators applicable on a firm level were called for. Biodiversity market shaping was introduced as a concept capable of directing attention to incentives and policies that could create markets for new biodiversity friendly business models. It was pointed that steps towards integration of biodiversity issues with economy should be taken already now, while there is also a need to continue and strengthen basic research on biodiversity. Nature restoration was discussed as topical issue relevant for Finland.

Results helping to understand the necessity of avoiding breaching ecological thresholds was called for. It was noted that even though the importance of biodiversity is generally recognised, the fundamental societal importance of biodiversity is not yet fully acknowledged and especially the specific sector-based implications of biodiversity need to be clarified. Research identifying incentives to act and consequences of (non)action was considered necessary. The workshop identified citizen movements, customer pressure, strong global commitments, and activities by science panels as factors advancing biodiversity R&I.

In the interviews, it was repeatedly pointed out that biodiversity research regarding species in Finland is at a relatively good level, but there are still many information gaps especially at the global level, for example in the biodiversity hotspots such as the Amazon. It was noted that biodiversity research and monitoring is underdeveloped in comparison with climate research.

Systemic interactions between climate and biodiversity were also emphasised as an important topic, especially since research tends to be siloed. There is a need for more integrative cross-disciplinary research. Importance of comprehensive assessment ensuring the identification and prevention of trade-offs between climate and biodiversity actions was noted, In Finland, there is a need for measurement of loss of biodiversity and GHG emissions in food production.

In addition to the need for new research on biodiversity, the workshop participants noted the need to synthesise existing knowledge in a concrete manner. The strong voice of traditional trade lobby instead of innovative businesses was pointed out as a risk for research policy in Finland. The workshop presented critique for funders focusing overly on single issues such as carbon-free society, neglecting other questions such as biodiversity.

4.1.4 Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Prioritised topic			
Better understanding of relationship between sustainability transition and local democracy: social preconditions and practices, local administration, legal and permit procedures	S,t	Improved implementation of wide variety of local level sustainability solutions, local acceptability (short term)	R
Other topics			
Soil research in built environment allowing improved utilization of urban ecosystem services.	A	Better planning practices and improved usability of urban spaces and resilience against climate risks (medium & long term)	R
Bioregional thinking: Better understanding of urban-rural interactions, e.g. distribution of emissions from production and consumption	S	Efficient and just utilisation of local resources within the environmental limits (medium & long term)	R
Research on building energy efficiency, especially related to old building stock and the whole lifecycle of the building	A	Efficient use of existing building stock (short to long term)	R

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

Relatively few potential concrete priority areas emerged from the interviews, primarily because the expertise of the interviewees represented mainly other areas, but also potentially reflecting the Finnish context of relatively small cities and absence of problems related to megacities.

Relationship between sustainability transition and local democracy was identified as the priority area in the workshop. The key issue here is the efficient utilisation of existing information to implement potential solutions. It was noted that we have lots of knowledge and solutions to promote sustainability transitions. The big question is how to get them as (political) priorities that will be efficiently addressed and implemented. Densification of urban areas was seen as a controversial goal potentially leading to decreased urban ecosystem services.

Overcoming the dominance of economic values in land use conflicts was raised as a concern. Wide-based land-use and sustainability perspective and research on the relationships between urban and rural was called for in order to understand spatial causalities. In some cases, current legislation and municipal ordinances and practices may create hurdles for innovative experimentations. So-called living labs were suggested for regulatory innovations in cities, such as green space co-development.

Allowing spatially and temporally limited experimentations of local democracy and participation could offer novel solutions and maintain the legitimacy for solutions. A key enabling factor is collaboration bringing different actors (so-called Penta-Helix approach9). Low number of active local volunteers and resulting participation fatigue was recognised as a risk factor, as well as the weak culture of local democracy, apart from the formal municipal four-year election cycles. Development of local level visions for sustainability transitions was considered as a possibility to create exiting Agenda 2030 implementation plans that could harvest the citizen interest in sustainability. Building action on city networks was seen as essential.

[9] involving Academy, Business, Public administration, Third sector communities, Funders

4.1.5 Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Prioritised topic			
Environmental effects of the energy transition in a context of rapid technological changes and significant investments	A,S	Identification of both negative and positive impacts to support decision making in the energy transition (short term)	N,I
Other topics			
Up-to-date information on energy usage	A	Balancing energy production and consumption, smart grids (short term)	N
Just land use in the energy transition	S	Improved acceptance of new energy solutions (short term)	R
Implementation of a new nature friendly energy system that meets needs and wishes of society	A	Identification of key levers for change (medium & long term)	N
Productization of nature friendly energy technologies	A,T	Business opportunities with simultaneous economic and environmental gains, better understanding of life cycle impacts (short term)	N
Fusion energy research	A	Abundant energy source (long term)	N,E
Sustainable electricity production	A,S	Electrification of the energy system (short & medium term)	N
Smart energy solutions	A,S	Efficiency from more intertwined roles for producers and consumers (short term)	N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

In the Finnish context, the theme ‘nature & environmentally friendly energy transition’ overlaps considerably with the theme ‘biodiversity and climate’ because of the strong position of bioenergy in the Finnish Energy system. Environmental effects of the energy transition were a priority brought up most frequently in the interviews. The concern was raised that the pace of the energy transition is so fast that not all environmental effects can be identified and measured factually. For example, the materials and minerals needed for climate friendly energy production and their environmental effects were something to consider, according to the interviewees. In the workshop, environmental effects together with social and cultural implications of energy transition were identified as a priority issue. It was noted that policies striving for energy transition tend to focus narrowly on carbon emission reductions and lack wider considerations, such as the risk of considerable increase of material use and overall energy consumption, or the biodiversity effects.

Identifying trade-offs between environmental, social and economic issues were highlighted. It was noted that many technological solutions already exist, but the key question is the wide-based implementation. Potential risks related to rapid implementation of energy transformation were noted. Participatory approaches and co-creative studies on the most suitable roles for national policies for creating business opportunities were called for.

4.1.6 Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Prioritised topic			
Overconsumption of natural resources: Sufficiency considerations, identification of boundaries for consumption	S,A	Decision-making helping to meet the environmental goals while securing adequate level of well-being (short term)	N,I
Other topics			
Regenerative economy and the social, political and societal dimensions of sustainability	S,A	Taking social and justice-related dimensions into account helps to understand e.g. implications of distribution of income for the sustainability transition (short term)	N,I
Impact assessment of research: identification of actual or missing societal impacts of (sustainability) science.	S	Science-policy interfaces supporting consistent generation and use of knowledge (short term)	N
Environmental risk assessment, safety and preparedness	S	Managing risks and allocation of roles and responsibilities. Helps decision-makers to prepare for different situations (short term)	N,I
Industrial sustainability transition: formulation of mission-oriented policies, creation of knowledge that helps to find out which functions of society are necessary, which must be protected, and which should be abandoned.	S	Large-scale implementation of policy targets aimed to transform production systems with strong state intervention (medium & long term)	N,E
Technological development that supports both climate goals and economic growth	A	Investments in such technologies support both the climate goals and economic growth (short term)	E,I
Research on system-level sustainability transitions, interactions between phenomena, planetary triple/multi-crisis	S	Adoption of systems thinking helping to address triple/multi-crisis and preventing creation of socio-technical systems which we are unable to change and transform (long term)	N,E
Research of the global logistics system and transport in the context of sustainability	S	More efficient, reliable and environmentally sound logistics and production chains (medium term)	E,I
Food transition and plant-based proteins	A	Environmental and health gains, economic restructuring of food system (short & medium term)	N
Basic research, theory-testing and comparative & longitudinal sustainability research*	S,T	Improved understanding of the prerequisites of sustainability transition	N,I
Geoengineering: Management of global climate change, especially studies related the socio-political implications	S	Successful management of global scale climate risks (long term)	I

Solution-oriented sustainability research focusing on readily applicable and scalable ideas and sustainability innovations, especially the piloting and scaling up	A	Rapid implementation of concrete and applicable solutions; e.g. changes in jurisdiction, technological development and the commercialization (short term)	N
Identification of efficient policy measures for sustainable economic transition	S	Large-scale emergence of novel sustainable business models (medium & long term)	N
Marine and freshwater research supporting sustainable blue economy	A	Fishing and other marine industries operating in a sustainable way (medium & long term)	N,I
The study of behavioural change and thought patterns in the context of sustainability to improve implementation of sustainability transition	S,A	Policy advice on the means for the implementation of sustainability transition (short term)	N,I
Identification of unexpected or non-recognised questions and risks	S	Capabilities to anticipate and address risks related to emerging questions such as micro plastics or large-scale issues such as environmental implications of social inequalities (short & medium term)	N,I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

Interviewees consistently brought up research priorities outside of the four predefined thematic clusters. Some of these research priorities overlap with multiple pre-defined themes, such as overconsumption and sustainable business practices and some, such as blue economy related to marine and freshwater research, stand apart as distinctive topics. Others can be seen as cross-cutting perspectives relevant for all four predefined themes, such as the social, political, and societal dimensions of sustainability. It was noted that land use is an example of a topic that connects biodiversity and climate theme with the theme.

The workshop identified overconsumption of natural resources as the most important single topic. It can be seen as an umbrella theme connecting other topics such as behaviour and thought patterns and economic valuation as background factors for overconsumption. Overconsumption was seen as a threat to several goals such as human health and well-being, economy, national self-sufficiency and security as well as societal resilience. Importance of overconsumption was also discussed under other themes.

Regenerative economy emerged as a one priority in the interviews. This topic could be considered a separate research priority emanating from broader economic sustainability transition research. It relates to the circular economy theme but emphasises more widely the value bases and long-term fairness aspects of the economy.

Another broad theme is systemic-level sustainability transition and interactions between phenomena. When addressing this theme interviewees utilized terms like 'multi-crisis,' 'planetary triple crisis,' and 'ecological triple crisis' to describe issues encompassing pollution, biodiversity loss, and climate change. This challenges the traditional positioning of institutions such as EPAs focusing only on the environmental issues.

The importance of studies capable of concretising unexpected or non-recognised questions and risks was noted, e.g. related to emerging questions such as micro plastics, surprises potentially hiding in value chains of clothes, or large-scale issues such as environmental implications of social inequalities. Solution-oriented research of jurisprudence was considered as a priority helping to implement the needed changes. Large-scale mission-oriented industrial policy aiming for sustainability transition was brought up as a potential priority area. Means for expediting the environmental innovations by small and medium-sized enterprises was another potential topic. It was noted that the structures of university research may inhibit or forestall collaboration with private sector.

4.2 Promising funding schemes

The four predefined CASRI themes are covered by various funding schemes, but as indicated in the previous section, various topics with inadequate funding can be identified under each theme. The results also indicated several possible additional themes. Since many of these emerging themes have essentially cross-national characteristics, potential new funding initiatives would likely benefit from cross-national collaboration between the funders. Based on the Finnish case, practices ensuring that the funding mechanisms remains transparent, simple and flexible are essential. The prerequisites for funding collaboration were considered most effective when the needs and goals of those involved in the funding were homogeneous; otherwise, lots of time and effort had to be spent negotiating compromises. Challenges identified within collaborative funding systems included bureaucracy and the time it consumes, differing viewpoints and objectives among stakeholders and their reconciliation, and, specifically for Finland, budgetary constraints, and austerity within public finances, which limit participation in collaborative funding. While participation of foundations in CASRI's collaborative funding system was seen as possible, potential limitations imposed by pre-defined purposes and missions of foundations were also raised.

National cooperation-based funding systems were seen as effectively preventing siloing, particularly in public administration. Collaborative schemes also enable broader and multidisciplinary work, which was seen essential for addressing sustainability issues. The interviewees most often mentioned the Strategic Research Council (STN; https://www.aka.fi/en/strategic-research/) research projects as examples of collaborative research, although these projects are funded by solely by government. These projects typically involve several universities or state research institutes and collaborate widely with different societal actors. The next most common effective funding collaboration mentioned by interviewees were Business Finland (https://www.businessfinland.fi/en/ formerly Tekes). However, one interviewee highlighted that funding collaboration worked better in the Tekes era and transforming to Business Finland has reduced the opportunity for collaboration with businesses and broader knowledge accumulation due to a focus on export sector. Tekes technology programmes were also considered successful, which according to one interviewee was due to clearly stated objectives and visible investments in research, technological development, and economic competitiveness assessment. For example, previous Tekes programmes (especially the Liekki and Liekki 2) which brought together companies and researchers, were seen to have generated a lot of expertise and innovation for the hydrogen sector.

In addition to the above, interviewees mentioned Finnvera's Team Finland cooperation, funding collaboration between different ministries, collaboration between private foundations and public funders, collaboration between ministries and other actors such as agencies and companies, as well as collaboration between municipalities. One interviewee mentioned the Strategic Centres for Science, Technology and Innovation SHOK (2008–2017) as a successful cooperation system because it brought together so-called “triple helix” consisting of industry, research and administration. According to other interviewee, however, SHOK's funding model was not effective. Divided views probably reflect different experiences but also indicate that evaluating the effectiveness of collaborative funding schemes is difficult and requires careful consideration of the evaluation criteria.

Regarding international cooperation-based funding systems, interviewees mentioned EU ERA-NET funding and Horizon partnerships. Nordic research collaboration within the NordForsk and the Bioeconomy in the North (a network of ministries and funding agencies from Canada, Finland, Germany, Norway and Sweden focusing on non-food / non-feed biomass resources exploitation) were highlighted as successful and effective cross-national collaboration. International co-funding systems were considered as beneficial because they improve the accessibility of Finnish researchers to international research collaborations. Horizon partnerships were generally considered useful but also criticised for lack of genuine collaboration effort sharing in some cases.

For successful collaboration between funders and researchers, the interviewees emphasized finding a balance between "bottom-up" and "top-down" approaches, ensuring commitment to projects at the researcher and developer level while maintaining thematic structure in operations. One idea involved seeking synergies with international development funding by the Ministry of the Foreign Affairs, as many development project goals were seen as aligned with sustainability objectives.

In Finland, the national level planning of R&I funding is carried out by the Government through Multiannual plan for research and development funding. The plan published in June 2024 indicates a process led by the Research and Innovation Council under the Prime Minister Office to form strategic direction of choices (Valtioneuvosto 2024, 30). The interviews highlighted that there is no society-wide consensus on the need for strategic choices over sustainability R&I priorities. This is also evident from other statements. For example, the trade union confederation STTK sees strategic choices as essential (STTK 2024), but the VATT Institute for Economic Research argue that state-led prioritization could lead to copying trends in already established innovation sectors, potentially hindering the development of genuinely novel innovations (VATT 2024).

Interviews also highlighted the need to find private investments. The Government's plan aims to "leverage" private sector funding through state investments channelled via Business Finland (Valtioneuvosto 2024, 15). Interviews indicated that in addition to long-term profit potential, motivating factors include intangible benefits like increased visibility from participating in collaborative funding and the opportunity to influence research and development agendas. Furthermore, the international success and competitiveness were seen as incentives for participation in international funding. The interviews also recognized the advantage of accessing larger pool of resources through joint financing schemes than individual investors could achieve independently. This aspect is reflected in the Government's plan, which proposes increasing national counterpart funding to enable participation in EU partnerships (Valtioneuvosto 2024, 27). On a broader societal level, enhancing Europe's competitiveness in the global arena was seen as a motivating factor.

4.3 Improving the Science Practice Policy interface (SPPI)

Interviews explored the interaction between science and other sectors of society in Finland**.** Nearly half of the interviewees perceived the current situation as predominantly negative. Two interviewees viewed the interaction between scientists and policymakers as functioning well, highlighting that in Finland cooperation between policy makers, business organizations and researchers is close and hierarchical barriers between actors are low. These observations echo previous research indicating a gap between science and politics in Finland, and the relatively recent origin of the attempts to build genuinely interactive relationships between researchers and decision-makers (Saarela 2020). Interviewees mentioned that the interaction between science and politics is slowly gaining recognition. This positive shift was attributed to the implementation of instruments fostering dialogue between science and policy, as well as emphasizing the importance of science panels and interactions with decision-makers.

There were differing views on the direction of development, with some perceiving a recent decline in interaction—especially during the current government term. The discontinuation of Government's analysis, assessment and research activities (VN TEAS, https://valtioneuvosto.fi/en/governments-analysis-assessment-and-research-activities) was identified as one factor contributing to this deterioration.[10] Some interviewees expressed a concern that policymakers currently find it difficult to recognize or value the perspectives and data provided by environmental research. Two interviewees expressed the view that research-based knowledge has weakened, partly due to the spread of disinformation on social media. Public debates, particularly online, were considered as inflamed, or even hostile, which may discourage researchers from engaging.

Various instruments fostering dialogues range from network actors serving as knowledge brokers to social media discussions. However, as noted by a recent study, information flow remains predominantly one-way (Juhola et al. 2024). The main platform for SPPI is the media, followed by various personal meetings. The role of the media as a key partner and mediator of scientific information was recognized also by interviews. According to the study, the only significant written source of information delivered for policymakers were policy briefs (Juhola et al. 2024). The interviews emphasized the success of concise and brief policy recommendations, contributing to in-depth dialogue. One interviewee informed about experience on influencing the government programme through broader impact assessments and subsequent in-depth discussions.

The interviews and the workshop indicated that research has been too isolated from the rest of society and genuine interaction with policymakers is difficult to establish. For example, scientific academies have not succeeded in bridging the gap between science and politics sufficiently, as suggested by one interviewee, requiring more iterative advisory roles and building dialogical elements. Despite not viewing the interaction between science and politics as optimal, interviewees did widely recognize various practices and actors that promote interactive relationships between them.

[10] in 2025, a new instrument has been set up to replace this. There is not much public information about this new 'VN Tutkiva' instrument yet (it is under construction), but during spring 2024, there will be more info.

When promoting dialogue between research and policy, it is crucial that scientific advice is based on factual research and that the prestige brought by research is not used to influence without scientific foundation. Building trust among actors was identified as essential for fostering interaction. Open and respectful dialogue fosters trust and subsequently facilitates cooperation between actors from different sectors. Cumulative learning is a crucial factor in promoting interaction. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) was mentioned as an actor fostering such learning.

To facilitate dialogue, many interviewees highlighted the importance of bringing together actors from different sectors to promoting interaction. Additionally, the movement of individuals between sectors was seen as a practice that promotes interaction. One interviewee suggested programmes or operating ecosystems organized by public administration or research funders where actors from various sectors are brought together. These ecosystems should include researchers, businesses, and decision-makers who could collaboratively develop solutions. To implement these solutions, the business potential of the solutions should also be assessed.

One perspective raised in the interviews was that linking research findings to concrete issues such as economic implications enhance the impact of scientific information. Previous research (Saarela, 2020) has emphasized the significance of boundary objects in facilitating interaction. For instance, the economic impacts of environmental phenomena can serve as a boundary object, bringing researchers and policymakers together around a common theme. In this context, one interviewee pointed out that utilizing research in policymaking is facilitated when researchers not only present the problems but also solutions, highlighting the importance of actionable knowledge.

Boundary organizations are institutions that, like boundary objects, bring actors together around scientific knowledge (Juhola et al. 2024.) Interviewees identified numerous organizations operating in Finland as intermediaries, either directly connecting researchers and policymakers or mediating information between them. According to interviewees, the strong institutional standing of intermediary organizations contributes to their effectiveness. For boundary organizations, the challenge of remaining neutral and trustworthy partners in highly politicized issues was highlighted. In the workshop, the problem of maintaining public perception of a neutral actor was discussed both from the perspective of science panels and individual researchers.

The Forum for Environmental Information (YTF; https://www.ymparistotiedonfoorumi.fi/english/) was seen as particularly significant. The YTF's events and gatherings, where actors from various sectors can meet and engage in dialogue, were viewed as effective in promoting interaction. Furthermore, the YTF also brings researchers to parliament for meetings and sessions that foster more informal discussions between researchers and policymakers. YTF also produces brief synthesis reports based on its activities (e.g. FEI 2024). In interviews, the multidisciplinary science panels and the synthesis reports they produce were highlighted. International science panels were also regarded as effective knowledge providers.

A frequently mentioned challenge was the lack of time or funding allocated to interaction. Time constraints were felt at every level, from knowledge producers to boundary organizations and end-users of knowledge. Boundary organizations were particularly seen as lacking funding. Not all funding programs acknowledge the resource need.

The interviewees noted the Strategic Research Council's projects for adequately funding not only research but also the interaction and dissemination of findings. The Council's role in facilitating dialogue was also attributed to program managers who act as connectors between researchers and policymakers within funded projects.

Individual interviewees also highlighted several other actors and methods as contributing to effective interaction between science, politics, and practice. These include the Metso programme utilising biodiversity knowledge and connecting forest owners and administration, policy-briefs from the Natural Resources Institute Finland (LUKE), and LUKE's TOIVO scenario focusing on increasing the added value of the food sector. Deliberative processes and citizen assemblies were mentioned, along with the Finnish Academy of Science and Letters' science sparring efforts. At the European Union level, the Joint Research Centre is recognized as a facilitator of interaction. Finally, interest groups such as NGOs, trade unions or employer associations were noted for their role in using and bringing together information provided by businesses, researchers, and science panels.

Most of the challenges identified by interviewees relate to contradictions between research and politics. One key contradiction originates from different temporal perspectives. Research often prioritizes longer-term perspectives and long-term follow-up studies, while politics seeks quicker application of results. Timing of interaction was also perceived as a challenge. Another contradiction relates to the earlier mentioned difference in interests. Environmental research aims to generate knowledge of ecological changes while politics involves a range of other factors, such as values or economic objectives, which may conflict with the information produced by research.

Individual mentions of challenges to interaction also included: a shortage of generalists, a lack of expertise or contacts among administration and politicians, the obscurity of scientific language and "acronym jargon," a lack of forum for free dialogue among politicians, the perception that science-policy interaction is unnecessary, a lack of commitment from those who use information, and researchers' reluctance to engage in open discourse. The challenges of interest conflicts, resource and expertise shortages, differing perceptions of time between science and politics, difficulties in timing interaction, and distrust of science were the same ones identified in previous research as obstacles to successful science-policy interaction (Saarela, 2020; Juhola et al., 2024).

4.4 Recommendations for CASRI by NKS

The interviews and workshop produced some general suggestions for the CASRI. Regarding funding, two key issues emerged. One emphasized that while aiming for diverse funders to support sustainability research is well justified, the number of funders shouldn't be so large that the instrument becomes overly complex and cumbersome. The other stressed the importance of including "next-step" funders in the financing mechanism, referring to post-pilot phase funding for innovations. To address this, emphasis was placed on evaluating the commercial viability and societal adoption of innovations at the beginning of funding. This suggest that the presence of businesses in funding structure would be desirable.

Involving a broader research community in shaping the R&I agenda to ensure that it is comprehensively grounded in solid research and provides well-founded perspectives was suggested. Another suggestion was to take a problem/challenge-driven approach when formulating the agenda, urging a thorough examination of the specific societal challenges.

The difficulty in defining "innovation" was noted. This is also related to the need for measurable goals within the agenda. The need for reconsideration of the four predefined themes emerged, encompassing other and cross-cutting themes such as regenerative development, economic transformation, and multi-crisis perspectives as key themes.

For the potential joint funding mechanism, interviewees highlighted good practices such as transparency, participation, dialogue, listening to all parties, shared responsibilities, and especially the need for a coordinating party to allocate resources and time for the interaction. Building trust between actors involved was considered crucial, along with planning a realistic timeframe. Considering collaboration between public actors and businesses, interviewees emphasized the need to critical assessment of the extent to which public actors can support individual private interests potentially deviating from public/common good. In collaboration between public and private actors, it is crucial to clearly map intangible ownership and intellectual property rights, good scientific practices, and publicity of the results from the outset. It's important to examine sector-specific operating logics to ensure best possible balance between commercial rights and open and free use of research results.

Generally, it was considered important to consider how to involve stakeholders with diverse backgrounds besides environmental agencies in funding sustainability solutions and how to reconcile their interests. The interviewees also called for evaluating the impact of activities and developing impact indicators, mentioning impact-based funding as a possibility. Planning for the applicability of the outcome, such as policy recommendations or innovations, was also considered important regarding impact.

Recognizing funders' motivations is essential for initiating international cooperation. It was suggested to conduct anticipatory and exploratory work with funders to understand needs and interests of funders. Another proposal was to involve a variety of funders in the strategic planning of EU funding instruments. This also prompted discussions about a more comprehensive national-level strategic guidance on funding, which would facilitate both planning and implementation of funding.

Interviewees suggested several considerations from a sustainability science perspective. Firstly, the project should explore how to combine long-term sustainability research with the ability to adapt to rapidly changing circumstances. Secondly, it's crucial for sustainability research to clearly define its own normative stance and communicate it effectively to all stakeholders. Furthermore, sustainability research and environmental data utilization should consider society as a whole, aiming to reconcile the interests of different actors. Beyond standard science-policy interaction skills, one proposal was to explore five "sustainability transition" capacities: systems thinking, future competence, ethical competence, communication skills, and problem-solving skills. Finally, when encouraging researchers to engage in interaction with politics, it's essential to consider the boundary work between research and political action while upholding independence and research integrity.

4.5 Reflection on the workflow

This report is based on observations from interviews, an expert workshop and a desk study conducted by CASRI project in Finland. The workflow followed the general description outlined in the introduction. A desk study starting from the four pre-defined CASRI themes was used to chart the landscape and to instruct the interviews. A total of 18 national key stakeholders were interviewed on the topic of sustainability research and innovation (see Appendix A).

Interviews were informed by the initial results of the desk study collating and reviewing a wide variety of documents (see the literature list; Appendix B). The interviews followed a semi-structured survey approach using the questionnaire outlined by CASRI and translated with slight adaptations in Finnish. The interviews were conducted during May-June 2024. Seven interviewees represented funding organizations for research, nine end-users of knowledge, and nine producers of knowledge. Six interviewees worked at background organizations that served in more than one role (e.g., ministries). Most of the interviews were conducted online via Teams (two face-to face interviews). Interviews were recorded and transcribed with automated transcription (GoodTape). All transcriptions were manually checked. Preliminary coding of the data was done with NVivo (version 12) building from the four pre-defined main themes of CASRI. The initial observations from the interviews and desk study were compiled to the interim report and summarised and discussed in the workshop organised on 22. August 2024 (see Appendix C). The workshop participants included seven of the interviewees and three additional experts (two persons representing R&I funders and one representing innovation research). The main purpose of the workshop was to prioritise and elaborate potential topics of for the SRIA and to discuss the initial findings. No major deviations from the initial findings emerged.

Some limitations should be noted. A key selection criterion for the interviewees was the diverse representation of funders, knowledge producers, knowledge users and intermediators. Importantly, policy makers and representatives of private businesses were missing from the interviewees. All participants represented their personal views and expertise and not the official views of their background organisations. Selection of the participants obviously influences on the issues raised as noteworthy. Overall, the participants expressed rather uniform views on the gravity of environmental challenges, probably because of their professional backgrounds related to sustainability issues.

The participants involved represent a wide variety of expertise and long-term experience on the environmental and sustainability research policy, funding and different topics of research and innovation. However, because of all-encompassing nature of the sustainability issues, aiming for a complete and comprehensive coverage of all relevant topics and concerns is not a feasible goal. In the Finnish context, issues related to resource intensive and export-oriented economy were emphasised. In particular, discussions on the global level challenges related potential funding schemes remained somewhat scattered. The results presented here are aimed to help the prioritisation of potential key issues from the Finnish perspective.

5 FLANDERS (BELGIUM) – National/Regional Report

Author: Kathleen Van Heuverswyn

SUMMARY IN FLEMISH

Nationale context

Het Vlaamse Gewest is een van de vier institutioneel bevoegde actoren in België met toegewezen, autonome institutionele bevoegdheden voor milieu-, omgevingsgerelateerde zaken. De bredere Belgische context, evenals de regionale context in Vlaanderen, worden gekenmerkt door een versnippering van bevoegdheden, hetgeen resulteert in een veelheid aan overheidsinstanties die betrokken zijn bij milieu-, omgevingsgerelateerde zaken. In Vlaanderen kunnen er 8 worden gekwalificeerd als Milieu(beschermings)agentschap. Sommige van hen hebben een expliciet mandaat voor onderzoek, anderen voeren onderzoek uit als een ondersteunende activiteit. Andere belanghebbenden bij milieuonderzoek in België zijn voornamelijk universiteiten en organisaties voor hoger onderwijs, in mindere mate particuliere organisaties (industrie en maatschappelijk middenveldorganisaties).

ES R&I-behoeften voor de 4 CASRI-thema's

In elk thematisch gebied konden prioriteiten voor onderzoek en zelfs dringende behoeften worden geïdentificeerd. Onderzoekstopics die goed zijn afgedekt door EU- en nationale beleidsagenda's lijken evenwel minder te worden gezien als een prioritaire behoefte, omdat politieke aandacht ook zorgt voor opportuniteiten voor financiering. Volgende onderzoeksbehoeften werden als belangrijk geïdentificeerd: nieuwe, ‘emerging’ topics binnen de thematische gebieden, onderwerpen die geen politieke prioriteit zijn, domeinoverschrijdende, transversale aspecten en langetermijnonderzoeksbehoeften die verder gaan dan de gebruikelijke looptijd van onderzoeksprojecten.

Financieringsmogelijkheden (NKS perspectief)

Vanwege de vele financieringsmogelijkheden van verschillende fondsen en programma's op nationaal en EU-niveau, is financiering een specialisatie geworden waarvan veel organisaties toegeven die niet volledig te beheersen. Het financieringslandschap is erg gefragmenteerd en veel organisaties vinden het moeilijk om de weg naar het best passende mechanisme te vinden. Nieuwe mechanismen, met eenvoudige administratieve en transparante processen, zouden welkom zijn als ze complementair zijn aan de bestaande fondsen en de huidige hiaten opvullen (emerging topics, domeinoverschrijdend, transversaal, lange termijn). Sommige EU HORION Partnerschappen worden beschouwd als een goede praktijk vanwege de combinatie van cofinanciering en coprogrammering.

Doorstroming van wetenschappelijk onderzoeksresultaten naar beleid – Praktijk – SPP en interactie - SPI

Alle Vlaamse Milieuagentschappen zijn op een bepaalde manier betrokken bij het proces van doorstroming van wetenschappelijke onderzoeksresultaten naar het beleid, in sommige of alle fasen van de beleidscyclus (beleidsvoorbereiding, beleidsontwikkeling, beleidsimplementatie). Er bestaan veel multistakeholder-overlegstructuren in Vlaanderen, vaak betrokken bij SPP als een van hun (vele) activiteiten of exclusief gewijd aan SPP en SPI.

Overheidsinstanties, incl. Milieuagentschappen, zijn goed vertegenwoordigd in deze structuren en nemen vaak een leidende rol op zich. De betrokkenheid van andere belanghebbenden varieert.

EXECUTIVE SUMMARY ENGLISH

National context

The Flemish region is one of the four institutional competent authorities in Belgium with attributed, autonomous institutional powers for environmental matters. The broader Belgian context, as well as the regional context in Flanders are characterized by a fragmentation of competencies, as a result many public authorities are involved in environmental matters, in Flanders, 8 of them can be qualified as Environmental (Protection) Agencies. Some of them have an explicit mandate for research, others perform research as a supporting activity. Other environmental research stakeholders in Belgium are mainly universities and higher education organization, to a lesser extent private organizations (industry and civil society).

ES R&I needs for the 4 CASRI themes

In each thematic area, priorities for research and even pressing needs could be identified. However, research topics that are well addressed by EU and national policy agendas seems less perceived as a priority need, because political awareness also creates funding opportunities. New, emerging topics within the thematic areas, topics that are not a political priority, cross-domain, transversal aspects and long term research needs beyond the usual duration of research projects have been identified as the most important research needs.

Funding options as seen by the NKS

Because of the many funding opportunities from different funds and programs at national and EU level, funding has become a specialization that many organizations admit not to master completely. The funding landscape is very fragmented and many organizations find it difficult to find the best fitting opportunities. New mechanisms, with simple administrative and transparent processes would be welcomed if they are complementary to existing schemes and cover the current gaps (emergent topics, cross-domain, transversal, long term). Some EU HORIZON Partnerships are considered as a good practice because of the combination of co-funding and co-programming.

Science Policy Practice & Interaction

All Agencies are to some extent involved in Science Policy Practice in some or all phases of the policy cycle (policy preparation, policy elaboration, policy implementation). Many multistakeholder concertation structures exist in Flanders, often involved in SPP as one of their (many) activities or exclusively dedicated to SPP and SPI. Public bodies, incl. Environmental Agencies are well represented in these structures, and they often take a lead role. The involvement of other research stakeholders varies.

5.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

5.1.1 National research context

About Flanders:

In Belgium environmental matters belong to the competency of the regional authorities: Flanders, Walloon region and Brussels Capital. The federal authorities have some attributed and residual powers. Because of the extent of the (constitutional) transfer, the regional level in Flanders is equivalent to the national level in other countries.

In Flanders, each policy domain has a 'department' responsible for policy preparation/support and several agencies, responsible for policy implementation. In the policy domain Environment, that distinction is not so strict as some thematic competencies have been fully transferred to the Agencies. Some cover the whole policy cycle, policy preparation – implementation – enforcement, some focus rather on implementation, some have their own research unit, one Agency is dedicated to research. In total eight Flemish public entities can be considered as Environmental Protection Agency within the policy domain Environment.

About the organisations contacted for the CASRI interview:

In most organisations (public and private, funding providers, knowledge providers, knowledge users) there is not one professional function or profile dealing with all aspects, or if they do, they cover it partially. A 'funding coordinator' or 'research coordinator' is the profile that is best knowledgeable about the topics covered by the interviews. Because in most organisations there is not one person who has a complete overview, for 6/15 interviews, a second interview was planned to complete the information, moreover, most interviewees contacted other colleagues to complete the information in the template.

This is an important aspect to take into account for CASRI for consultation and dissemination purposes. It also implies that in organisations without one centralised contact point, opportunities for networking, funding and SPP might not be detected because of fragmentation.

About categorisations and CASRI themes:

Flanders has a dedicated Agency for Immovable heritage, the focus is specific but there are a lot of interfaces with circularity (of heritage materials and practices, re-usability of materials), climate change and adaptation (not only protection of heritage but also how heritage can be a resource to tackle current challenges), energy transition (also both ways: adapting heritage but also taking into account heritage practices). It is typically a mix of a specific thematic focus and cross cutting, multidisciplinary aspects. Their needs reflect the complexity of navigating in a fragmented context (institutional powers, thematic categories, funding programmes).

About research and other 'needs':

Needs can be very diverse and are often not limited to knowledge: other needs are policy support, technology, citizens' awareness, societal acceptance, tools and budget for demonstration and implementation, monitoring methodologies and tools/instruments, understanding and leveraging human behaviour.

Research and Innovation are always covered as a (natural) duo, but the actors/stakeholders, the needs, exploitation requirements and impact goals and criteria can be very different.

General observations on Environmental and Sustainability Research & Innovation – R&I needs & gaps:

Input for research agendas can be collected from:

- Existing international, EU, and national research agenda's;
- EU/national/regional policy documents and strategies;
- Research results (research project conclusions and recommendations) or monitoring activities;
- Stakeholder surveys and events;
- Activities within multistakeholder networks.

National/regional research agenda's do not necessarily have a corresponding funding budget (and can rely on allocated research budgets); not all organisations have a formal research agenda (some have a thematic focus, or a list of research priorities as part of their mandate and the overall business development plan).

General observations on prioritising R&I needs & gaps:

- 15 interviews at national level are not sufficient to be representative to establish priorities.
- The workshop focussed on criteria to define priorities for a strategic research agenda at EU level. The following criteria were proposed:
  - Common challenges in the EU member states
  - Generic aspects of thematic topics
  - Cross-cutting issues

5.1.2 Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Materials sufficiency: More policy instruments for sustainable consumption/production	A	Why: to counter the lack of awareness and change in mentality Expected impact - short and long term: reducing materials footprint	All
Soil health care: Increased awareness and policy for prevention, avoiding restauration	S,A	Why: need to achieve a shift in attitude from restauration to prevention Expected impact - long term: healthier living environment/improved health, cost-efficiency	All
Waste prevention: Increased awareness, more innovative approaches such as SSbD – Safe & Sustainable by Design	S,A,T	Why: need for new circular economy strategies, sustainable consumption/life styles, .. Expected impact - short term: supporting the transition to a circular economy	All
Emergent contaminants (PFAS, …) and soil remediation: Technological innovation, increased awareness, more knowledge	S	Why: too many short term projects, long term effect/impact monitoring needed Expected impact: More accurate knowledge based on projects take into account the timespan of studied processes / probable timeframes of effect manifestation/project duration taking into account temporal and spatial scale of studied objects	All
	T	Why: structural monitoring and structural funding of infrastructure (equipment, stakeholder involvement) Expected impact: the only way to assess long term effects is continuous monitoring at an appropriate spatial scale	All
	S	Why: low collaboration between different disciplines for setting thresholds for soil and water, food, humans	All

		Expected impact: a more coherent holistic approach covering all disciplines involved	
Risks of chemicals: More knowledge on risks, on cumulative effects, on mixtures, on ecotoxicity, increased awareness, more policy initiatives	S	Why: knowledge needs on multidisciplinary interactions and policy support to transcend fragmentation Expected impact - Short term priority, long term goal: prevention of risks of chemicals	All

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

5.1.3 Biodiversity and climate

The list of research needs is mainly based on the research agenda of INBO (Institute for Nature and Forest Research). These needs have been validated, as being important, by stakeholder surveys and consultation[11].The topics listed below are challenges identified by INBO as 'needs and questions from policy and practice'. The topics are not further elaborated with NKS and the kind of knowledge need and impact are not specified.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Genetic diversity			
Agroecology and nature restoration			
Soil Biodiversity			
Decline in pollinators			
Pollution as a major driver of biodiversity loss			
Ecosystem-based mitigation			
Sustainable water system restoration			
Climate adaptation of species and ecosystems			

[11] The results are published in the INBO report 'INBO on the road to 2030'

Nature and health, from cure to care			
Nature and Economy			
Innovative monitoring techniques, Ecosystem monitoring and ecosystem accounting			
Challenges in human-wildlife coexistence			
New challenges for forest research			

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

5.1.4 Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Rural bio-economy	S	Why: lack of knowledge/available research: there is a need for more evidence based input for policies and to develop implementation plans at regional level. Systemic refers to the need for cross-entity collaboration in order to transcend the opposition of rural versus urban development and the role of peri-urban areas. Expected impact – short term: filling a knowledge gap to be better informed to elaborate coherent policies and implementation plans.	R, E
Landscape quality and maintenance	S		R, E
Liveable and vibrant villages, incl. food strategies	S,A,T		R, E
Agroecology	S		R, E
Methodological (systemic) approaches for the implementation of Open Space Programs (water, soil)	S	Why: lack of knowledge on scalability, ways of collaboration Expected impact – short term: further development of methods and promoting their implementation (towards mainstream approach)	R, E

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

5.1.5 Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Societal acceptance of pressing transitions (climate, food): changing mentalities and behaviour	S,A	Why: level of effective change of mentality is too limited compared to the pressing needs Expected impact – short, mid, long term: broader societal engagement for addressing the major societal challenges	R, E
Methods and techniques to ensure implementation and valorisation of roadmaps and pathways, engaging all stakeholders	T,A	Why: roadmaps and pathways are elaborated for major societal challenges, but techniques and methods lack to ensure their implementation Expected impact – short, mid-term: effective implementation, closing the entire policy cycle	All

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

5.1.6 Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Human biomonitoring, e.g. for emerging contaminants and health impact	S	Why: more knowledge on interactions between disciplines Expected impact – short and long term more reliable knowledge through transcending fragmentation, human biomonitoring acknowledged as an instrument for policy preparation and evaluation	All
More support for forestry, complementary to agriculture	S	Why: bridging the current gap of more support to agriculture	R, E

		Expected impact – short and long term: more balanced and complementary approaches	
Geology	S	Why: More knowledge on possible exploitation and corresponding risks and opportunities; more knowledge on possible critical raw materials for economic resilience Expected impact – short term: creating opportunities for land and spatial planning and for climate change resilience	R, E
More integration of political and social sciences in environmental sciences	S,A	Why: need for more understanding of behavioural aspects, e.g. to accelerate a shift towards more sustainable habits Expected impact – short and long term: a more embedded attitude and mentality towards sustainable living	All
Cultural/Built Heritage as structural element in climate adaptation, circular economy policies, research and approaches, instead of asking exceptions, CH should be integral part of the approach with a focus on the added value of CH practices	S,T	Why: Policies are elaborated without taking into account CH practices that could be a source of inspiration Expected impact – short and long term: Embedded energy as one amongst other measures as a circular economy approach	All
		Why: to little interest in the study of ancient systems of heating, irrigation etc. Expected impact – short term: existing/old practices could bring added value and could even be more efficient	All
Research funding for implementation of new EU legislation, e.g. new obligations on monitoring	S,T	Why: new EU legislation might impose obligations for which no data yet are available Expected impact – short & long term: to ensure a more proactive approach for the implementation of new EU legislation at national level, to ensure mechanisms are prepared and in place when the legislation comes in force	E
Systemic and holistic approaches, interactions between disciplines	S	Why: EU policy and funding strategies are still fragmented, and there is no overarching vision Impact – short and long term: avoiding cross discipline collateral effects, side effects, spill overs, … = truly sustainable and structural approach, just transition	All
Holistic land/living environment vision and approaches	T		All
More coordinated action of fragmented initiatives	S	Why: despite a lot of innovations and innovative approaches, upscaling of good practices through the whole	R, E

		chain of all actors involved is challenging, as well as the societal acceptance of private customers/end users (because of additional costs) Expected impact – long term: more coordinated, aligned approach	
Cumulative effects		Why: More knowledge on cumulative effects, interactions, cascading effects, etc. e.g. between chemicals (nitrogen, PFAS), between chemicals and radiation, chemicals and vibration etc. Impact: raising awareness, policies and strategies, prevention of risks	
Research concerning the need and how to shift from sustainability to a balanced approach between (EU) autonomy and sustainability	S,A,T	Why: need for more understanding and instruments how to deal with the change in geopolitical landscape which increases insecurity in international economic markets (technology, materials, resources) Expected impact – short and long term: to increase EU production autonomy (EU mining, resources for biomass)	R, E
Modelling (spatial modelling, systems dynamic modelling, …)	S	Why: More advanced modelling, more data, more standardized methods and data collection, interchangeability and interconnectedness, innovative measurements methods Impact: more applications such as compliance management applications of modelling, applications for decision support etc.	All
Lack of real measurements as a complement to simulations		Why: Measurements give a real and often more reliable assessment of the impact of energy or climate adaptation practices Expected impact: more realistic assessments	

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

5.2 Promising funding schemes

Findings on impactful research agenda's:

- Impactful international and EU research agendas are those with funding, e.g. EU HORIZON;
- Agendas and corresponding funding opportunities to collaborate with other experts in other EU Member States, e.g. EU HORIZON;
- Research combined with implementation, e.g. EU Interreg, LIFE;
- Policy documents, strategies and legislation are an inspiration for research agendas because of the likely political/policy support, e.g. European Green Deal;
- Agenda's where there is the possibility to steer the agenda as member of the steering or technical committee (Funds and Programmes);
- Agendas elaborated with other stakeholders (bottom up and top down), e.g. coprogramming of Partnerships (DUT, Biodiversa+, PARC, …) are considered relevant.

Impactful as a criterion for funding schemes is mostly determined by the thematic relevance (per organisation) and relevance of the type of activity (basic research, applied research, implementation, outreach, etc.), secondly by the type of partners/stakeholders involved.

In terms of impactful funding schemes, there is a broad variety of different types of schemes in terms of funding %, scope, objectives, type of funded activities and expected outcome, duration, budget, partners coalitions, etc. The most important findings from the interviews and the workshop include:

- No international funding schemes were mentioned;
- Many EU programmes and funds are considered impactful: HORIZON Clusters, HORIZON Missions, HORIZON Partnerships, LIFE, Interreg, ESPON, Innovation Fund;
- Some stakeholders have (different) basic/structural funding, e.g. competent authorities (EPAs), academia, research institutes, … depending on their profile and mandate;
- There is no comparable basic/structural funding for industry and civil society, or even for university colleges; for them project-based funding is a structural need, co-funded projects are challenging;
- Some EPAs are also funders, some funding ensures long term collaborations, e.g. on technological research, other funding is allocated through calls;
- Co-funding takes a share in either the general or dedicated research budget.

Three types of funding can be distinguished (Figure 5.1):

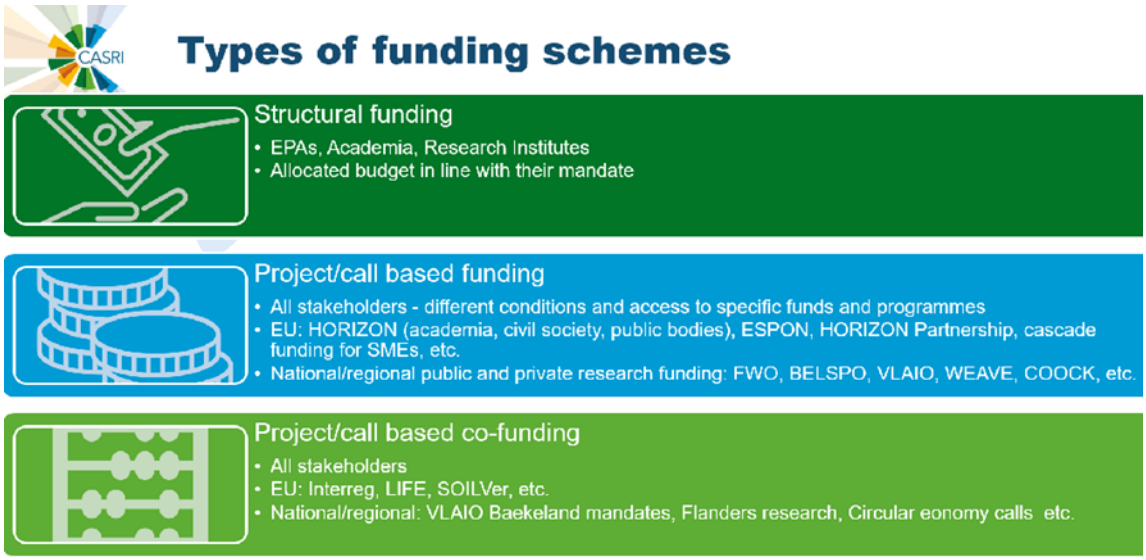

FIGURE 5-1 DIFFERENT TYPES OF RESEARCH FUNDING

Challenges to consider for new funding mechanisms:

- A clear focus and unique selling point for end users to enable the assessment of relevance compared to the multitude of available funds and calls;
- Ensuring alignment and clear added value of new compared to existing instruments;
- (for all EU funding mechanisms) setting up a consortium with other EU partners is challenging because they are not natural project partners (see also below in one of the recommendations);
- Ensure exploitation potential of the results for private partners and authorities.

Possible motivations to join a cross-national funding initiative:

- Multistakeholder participation, incl. field partners;
- EU projects with a focus on common challenges;
- Research in combination with implementation for topics that are no longer high-level priority (long term);
- Research on new emerging topics not yet on the political agenda;
- Opportunities for demonstration (for EPAs);
- Research on cross-cutting or generic (not country specific) themes.

Examples of good practices:

- Joint funding public funds and industry, e.g. Baekelandt mandates;
- the Weave initiative, a bottom-up cross EU initiative developed by EU research funders and embedded in Science Europe, to support excellent EU collaborative research projects across national and regional borders;
- Inspiration from the SOILVer initiative: the initial motivation to join and the added value of the funding scheme was its relevance when there was a lack of EU Soil Policy and funding opportunities. It has become less relevant since the EU SOIL Mission;
- Similar to SOILVer: EMA Soil Monitoring was relevant until there was a EU Soil Observatory established;

- EU funded (HORIZON) partnerships, as cross-national funding schemes: national resources are still available to the national experts while they collaborate with other EU MS experts and the Commission funds the more intense collaborative work packages.

5.3 Improving the Science Practice Policy interface (SPPI)

SPPI is well covered in Flanders, through 1) many concertation structures, 2) information/research/data platforms and 3) activities (events):

- Structures such as Circular Economy Policy Research Center – CE; Multistakeholder network for Emerging Soil Contaminants – Emconsoil; Knowledge Centre for Agrarian Heritage - CAG, Triple helix spearhead clusters for innovation (industry, knowledge institutes and authorities), etc. and many thematic advisory councils.
- Besides the individual websites of public and private organisations where research and monitoring results are shared, databases are important instrument to disseminate research results, such as Open-source Database Geology Flanders – Databank Ondergrond Vlaanderen - DOV: accessible for all possible end users and FRIS – Flanders Research Information Space (management by the Department of Economy, Science and Innovation)
- Many activities are organised, individually or jointly, such as events, yearly thematic days, awards, surveys, etc.

Challenges raised during the interviews relate to:

- Monitoring and evaluation of research impact, this is either a recent activity (OVAM, EWI) or not a current practice;
- The challenging acknowledgement of the relevance of applied sciences/research and collaborative actions (with end users) at local level;
- Challenging coordinated collaboration between different types of organisations involved in R&I and exploitation of R&I results in the field;
- How to reach a broad diversity of very different stakeholders;
- Continuation of fundamental research to ensure market uptake;
- The challenging landscape of project-based finances for R&I (in se short term contracts and continuous uncertainty of sufficient funding for continuity);
- The structural need in every thematic area for policy support/instruments and social sciences knowledge and instruments to shift mentalities and attitudes for structural change related to the big societal challenges. This is a short-term need.

Interesting and inspiring SPPI practices:

- On interpersonal skills: Circular ambassadors, who followed a dedicated training program on circular economy. This initiative will be extended to the EU level;
- Monitoring system DOMES[12] (Gommers & Wittebolle, 2022)– 7 pathways for direct, indirect and other ways of research up take and impact on policy
- Stakeholder management training and collaboration with sociologists

[12] https://www.omgeving.vlaanderen.be/nl/monitoring-en-evaluatie-doorwerking-onderzoek-0

- University colleges have a large network of local authorities and local businesses. SPP starts from a bottom-up approach, either based on the researcher's own expertise (identification of gaps and needs) or through the collaboration with local partners (public and private organisations). SPP is very needs driven and focused on concrete needs.

5.4 Recommendations for CASRI by NKS

Some recommendations, as expressed by one or more interviewees and discussed during the workshop:

- The thematic relevance is the most decisive criterion to choose a certain funding scheme;
- Crosscutting themes are seen as most relevant to deal with in cross national projects;
- In a strategic agenda, priority could be given to topics and projects
    - that have the capacity to cover different stages of the policy cycle and can leverage effective change, e.g. through the combination of research as input and substantiation of policy preparation (cf. Regulatory Impact Assessments) – implementation and reality check;
    - that are intrinsically holistic, e.g. covering the whole process/chain soil – crops – food – health;
    - which focus on long term aspects (long term research and monitoring);
- An EU research agenda should focus on EU topics, because of EU competencies and common policy and legal framework in the MS, because of the thematic relevance or because of the cross-border dimension (e.g. materials sufficiency, not waste prevention);
- Structural collaboration with other stakeholders from defining the agenda to being project partners is considered very useful, because of the end user driven approach. Structural knowledge platforms and communities (beyond the duration of the project) are considered useful as a supporting instrument to gather all stakeholders (who do not organically find each other in daily life);
- New mechanisms could/should fill gaps and learn from existing schemes: no duplication;
- The need for result-oriented research to make it attractive for other stakeholders such as private sector and civil society;
- Pooled schemes might be challenging for these other stakeholders with no dedicated/allocated/fixed research budget;
- If new mechanisms – then best also alignment with/of existing schemes, preferably simplification of existing schemes based on a comprehensive analysis of strengths and weaknesses of existing funding schemes;
- A governance structure where policy domains provide funding to one centralised national/regional funding agency is to be considered. The idea for a Governance structure, e.g. a National or Regional Funding Agency is to reduce the current fragmentation among dedicated funding agencies for specific target groups (academia – e.g. FWO – Fund for Scientific Research, industry – e.g. VLAIO – Flemish Agency for Innovation and Entrepreneurship, civil society – e.g. King Baudouin Foundation) and the many funding and subsidies streams from Ministerial Departments and Agencies. In addition, there are a multitude of NCP (more than 30) for EU Funding. Centralising the management of national funds and EU decentralized funds and information from International and EU centralized funds at national level could make the management of those streams more efficient and transparent and could lower the threshold for possible applicants;

- In cross-national pooled funding, additional funding support for stakeholders with no dedicated/allocated/fixed research budget might be a needed as a supporting instrument to ensure a quadruple helix representation: Cross national pooled funding could go in pairs with Structural financial support from national authorities to lower the threshold for participation and enabling university colleges focusing on applied research to participate and by extension, all other quadruple helix stakeholders who do not receive structural research budgets from public funds;
- Different stakeholders have different needs which should be considered in multistakeholder projects (academic partners are happy with research funding, regardless of TRL, the private sector prefers (locally) exploitable results, competent authorities prefer actionable results).

5.5 Reflection on the workflow

The templates for the interviews covered a lot of information and questions that are not 'usual' (not a usual perspective), which made it challenging to address all topics during 1 interview. The approach was adapted to address as much template questions as possible:

- Desk study to prepare the interview;
- The template as such was shown on screen during the interviews to keep focus;
- The template was completed with notes from the interviewer after the interview;
- The draft template was sent to the interviewee to complete;
- For several organisations, two sessions have been conducted to cover the whole template; in addition, to complete the template, interviewees contacted other colleagues.

This made the process to collect information much more time consuming than expected.

In most organisations, it is impossible for one single person to answer all the questions. A dedicated function for project funding is the most suitable contact person with most organisations.

Much of the required information is not explicitly available:

- E.g. on networks, this is very individual information, every researcher or policy advisor has its own networks, not necessarily know to other colleagues;
- Not every organisation has a formal research agenda or a formal process to decide on research priorities and preferred funding schemes;
- The desk study of organisations' website could not cover many of the requested information.

Whereas desk study and interviews could focus on one organisation with their specific thematic focus, mandate, etc. the workshop preparation and discussion clearly showed how challenging it is to establish priorities or to identify recommendations with a multistakeholder group. They all have different basic funding and different funding needs, they have different research needs, they have a different place and role in the policy cycle.

Moreover, the number of interviews and participants in the workshop are considered too limited to present the results as validated priorities and firm recommendations. They are an indication of needs and suggestions, which need to be discussed and validated with a much larger group of stakeholders.

6 FRANCE – National Report

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Country report specific abbreviations

ANR	Agence Nationale de la Recherche - National Agency for Research
ANCT	Agence Nationale de la Cohésion des Territoires - National Agency for Territorial Cohesion
ANRT	Association Nationale de la Recherche et de la Technologie - National Association for Research and Technology
ADEME	Agence de la Transition Ecologique - Agency for Ecological Transition
CIR	Crédit Impôt Recherche - Research Tax Credit
GIEC	Groupe d'experts intergouvernemental sur l'évolution du climat - Intergovernmental Panel on Climate Change
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
PEPR	Programme Equipement Prioritaire de Recherche - Priority Research Equipment Program
POPSU	Plateforme d'Observation des Projets et Stratégies Urbaines - Platform for Observation of Urban Projects and Strategies

SUMMARY FRENCH

RÉSUMÉ EXÉCUTIF

Ce rapport a été rédigé par les équipes du Service de la Recherche et de l'Innovation du ministère français en charge de l'Environnement - Commissariat Général au Développement Durable (CGDD). Ce service ne mène habituellement pas directement de travaux de recherche, son rôle étant davantage orienté vers le financement, l'orientation et la coordination de la recherche dans le champs des politiques publiques relevant du pôle ministériel de la transition écologique. Des experts en sciences sociales ont été mobilisés pour les entretiens et la rédaction de ce rapport. Toutefois, en raison de contraintes de temps et du manque d'expertise – qui reste fragmenté et encore en construction en France –, il a été décidé de ne pas explorer la question des systèmes de production résilients, neutres en carbone et circulaires, et de concentrer l'analyse sur les trois autres thématiques.

Une remarque générale, mais particulièrement importante, spécifique au contexte français, est que la recherche est plutôt bien financée par des initiatives publiques et gouvernementales nationales.

Des agences telles que l'ANR et l'ADEME sont reconnues et disposent de ressources substantielles, leur permettant de financer, souvent via des appels nationaux, des projets de recherche académique, y compris sur des programmes de longue durée (jusqu'à 5 ans). Ce contexte a été souligné par la majorité, voire la totalité, des chercheurs interrogés.

Thématique CASRI : Systèmes de production résilients, net-zéro et circulaires

Comme mentionné précédemment, il existe actuellement un manque d'agenda stratégique et de programme de financement coordonné sur cette thématique en France. Diverses initiatives sont identifiables, notamment dans les secteurs de l'agroalimentaire, de la gestion des déchets, de l'énergie et dans certaines industries. Malgré les programmes de l'ADEME sur le sujet, le paysage demeure fragmenté. Un agenda de recherche et d'innovation structuré pourrait contribuer à fédérer une communauté de chercheurs et d'acteurs, comparer les projets existants et développer des travaux plus larges sur ces enjeux.

Thématiques CASRI : Biodiversité et climat ; Urbanisation durable et transition énergétique

La R&I en Environnement et durabilité sur les questions de biodiversité et de climat ont constitué l'un des sujets centraux lors des ateliers avec les NKS. Ces dernières ont souligné l'existence de programmes de financement français (notamment ceux de l'ANR) sur ces thèmes. Les parties-prenantes ont insisté sur le fait que le financement sur ces enjeux doivent encourager la transdisciplinarité et la co-construction des questions de recherche et du projet de recherche avec une pluralité d'acteurs (citoyens, associations, entreprises, collectivités locales, etc.) dès les premières étapes du processus. Les financements devraient donc prendre en compte le temps et les "coûts de transaction" de ces démarches collectives, où les sciences sociales doivent également être mobilisées, même si elles peinent parfois à converger sur des agendas de recherche communs.

Un contraste net semble exister entre les acteurs qui bénéficient déjà de financements via l'ANR, les PEPR ou POPSU, et ceux qui n'y ont pas accès. En effet, les "coûts d'entrée" de ces programmes (et a fortiori des programmes européens) sont élevés pour les petites associations, les entreprises et les collectivités locales. Plus précisément, l'ANR et le PEPR financent directement uniquement les laboratoires de recherche. Construire un réseau de partenaires pertinent est une tâche complexe et chronophage, et monter un projet (ainsi que le gérer) nécessite des ressources administratives importantes.

Les parties prenantes ont ainsi souligné la nécessité de développer davantage de plateformes d'échanges, des "laboratoires" où tous types d'acteurs intéressés pourraient dialoguer, présenter leurs enjeux et envisager des collaborations.

Plusieurs parties prenantes ont également pointé le manque d'intégration des aspects réglementaires et des politiques publiques dans de nombreux projets et schémas de financement.

Options de financement perçues par les parties prenantes

Les parties prenantes sont généralement bien informées des initiatives nationales de financement de la recherche et de l'innovation dans leur domaine. Les initiatives récentes, comme les programmes de l'ANR et les PEPR, sont spontanément citées par la plupart d'entre elles. Bien que ces initiatives couvrent un large éventail de sujets et offrent diverses opportunités de financement, les NKS estiment qu'une vigilance particulière est nécessaire : certains sujets restent insuffisamment financés, rendant difficile la production de recherches exploitables/actionnables.

Un écart manifeste existe au niveau national entre les acteurs impliqués dans des projets européens (généralement de plus grande envergure) et ceux qui dépendent des dispositifs nationaux. Le coût d'entrée aux financements européens est jugé élevé, et certaines structures affirment ne pas disposer des compétences, des ressources humaines et du réseau nécessaires pour tirer pleinement parti de ces opportunités. C'est le cas de nombreuses associations, collectivités locales et certains laboratoires de recherche, en particulier dans les sciences humaines et sociales.

Interaction entre Science et Politique (Pratique) (SPPI)

Presque toutes les NKS ont déploré le manque d'interactions entre la science et la politique, soulignant que la culture scientifique devrait être promue au sein des sphères politiques et administratives. Le transfert de connaissances via des collectifs académiques produisant des expertises et des conseils et suggestions de politiques (comme l'IPBES ou le GIEC) a certes influencé les politiques environnementales françaises, mais il nécessite des stratégies complémentaires pour un meilleur ancrage.

Cette interface pourrait être améliorée par la création, aux niveaux national et local, d'espaces de rencontre réguliers entre scientifiques et décideurs, pour favoriser l'apprentissage mutuel et une compréhension partagée.

EXECUTIVE SUMMARY ENGLISH

This report was written by the staff of the Research and Innovation Service of the French ministry for environment - Commissariat Général au Développement Durable (CGDD) - which does not usually directly conduct research, being more focused on research funding and orientations. People trained in social sciences were mobilized for the interviews and the writing of the report but, due to time constraints and a lack of expertise of this specific field - which is very fragmented and still in construction in France-, it was decided not to investigate the resilient, net-zero, circular production systems and to concentrate on the other three topics.

A general and very important remark that makes the French context specific is that in France research is rather well funded by public and governmental initiatives. Agencies such as ANR and ADEME are powerful and rather well funded. That allows them to finance, usually via national calls, academic researchers even on long-term programs (i.e. up to 5 years). This situation was highlighted by many, if not all the academic interviewees.

CASRI Theme Resilient, net-zero, circular production systems

As mentioned above, there is currently a lack of strategic agenda and coordinated funding options on the "Resilient, net-zero, circular production systems" theme in France. Diverse initiatives can be identified, notably in agro-food systems, waste management and energy in some industries. Despite ADEME initiatives on the topic, the landscape remains fragmented and a R&I agenda on the topic could contribute to better structure a community of researchers and practitioners, confront the current existing projects and develop broader research and projects on these issues.

CASRI Themes Biodiversity and climate; Sustainable Urbanization and Energy Transition

Environmental and Sustainability R&I on Biodiversity and climate were one of the central topics during the workshop with the NKS. They underlined the existence of French funding programs (notably by the ANR) on the theme. They all insisted on the fact that funding on these issues should encourage transdisciplinarity and the co-construction of problematics and research with a plurality of actors (citizens, associations, firms, local authorities …), as early and as seriously as possible in the process. Fundings thus should consider the time and the "costs of transaction" of such a collective process, where social sciences should also be mobilized (even if it is sometimes difficult to converge on research agendas).

There seems to be quite a contrast between NKS who already have access, through ANR, PEPR or POPSU, to research fundings giving them these kinds of opportunities and, on the other side, those who don't. The “entry costs” of such programs are indeed very high for small associations, firms and local authorities. In fact, ANR and PEPR finance directly only research laboratories. Building the pertinent network of partners is a complex, time-consuming task, and building a project (and running it) requires important administrative resources.

NKS thus pointed at the necessity of further developing discussion platforms, “labs” where all kind of interested actors could exchange, present their stakes and eventually envisage collaborations.
Several NKS also pointed the lack of integration of regulatory aspects and public policies within many projects and funding schemes.

Funding options as known or seen by the NKS

NKS are generally aware of and well informed on the national R&I funding initiatives in their field. Important recent initiatives such as ANR programs and PEPR are spontaneously quoted by most of them. Even if these initiatives cover a wide range of topics and provide diverse funding opportunities, NKS also assert the importance of a certain vigilance: some topics remain poorly or under-funded and thus have difficulties to result in actionable research.

There clearly is a gap at the national level between actors that are or have been implied in (generally larger) European projects and funding and those who rely on national schemes. The cost of entry of European funding is considered high, and some structures claim they do not have the know-how, the human resources and the network needed to really benefit from entering European projects. That is the case for a lot of associations and local governments but also for some research labs – especially in social and human sciences.

Science Policy (Practice) Interaction (SP(P)I)

Nearly all NKS deplored the lack of interaction between science and policy; and underlined that scientific culture should be promoted among political and administrative spheres. Knowledge transfer through academic collectives which produce expert knowledge and provide policy advice and options (IPBES, IPCC) has nevertheless significantly influenced French environmental policy but needs complementary strategies for effective uptake.

This interface could be improved via the creation, both at the national and the local levels, of regular meeting spaces, between scientists and policymakers, as places for co-learning and mutual understanding.

6.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

6.1.1 National research context

The French research context can be characterized through a fragmented agenda, that already encompasses a wide range of ES R&I.

Different institutions indeed implement agenda and funding programs on the concerned topics. This results in a good coverage of the different topics studied in CASRI - except for the following cases, mentioned by the NKS: some systemic approaches of resilience in contemporary societies seem to lack funding, and, as it was mentioned earlier, France currently lacks a strong R&I agenda concerning “Resilient, net-zero, circular production systems”, and initiatives that could strengthen cooperation between the diverse actors already involved in the topic.

Many funding institutions mention the 17 Sustainable Development Goals developed by the United Nations[13] as the general frame through which they approach ES issues.

Some R&I programs central to French research infrastructure appeared very structuring in the recent years for the topics discussed by CASRI: ANR programs[14] (1 billion Euro in 2023), France 2023 - PEPR[15] (3 billion Euro for the program which covers 5 years). See table 2-1 to see how CASRI themes link to PEPR. Both those programs cover a wide range of topics and research projects. They are aimed at fundamental or applied research, and consortia and initiatives generally involve mostly academic actors.

In 2024, the France 2030 plan is funded with 8.4 billion Euro for a period of 5 years. It focuses on the following 10 themes: industry decarbonization, renewable energy, low-carbon mobility, recyclability, bio-based products and sustainable fuels, hydrogen, buildings, responsible digital technology, forest and wood, water. As part of this 2030 plan, a 3 Billion Euro funding initiative is dedicated to research through PEPR (Priority Research Programs and Equipment). The PEPR initiative funds fundamental and applied research in support of acceleration strategies. The objective is to develop technological champions in strategic areas for the French economy and sovereignty, such as technology, economy, society, and environment.

Sustainability is also present on the agenda of more thematic programs, carried by agencies such as the Platform for Observation of Urban Projects and Strategies (POPSU), the National Agency for Territorial Cohesion (ANCT) and the Agency for Ecological Transition (ADEME). Programs conducted by these agencies are more likely to encompass actionable research and innovations. They are also more prone to associate local authorities, private actors, associations. They can also be articulated with the implementation of a public policy. The main tool to steer R&I in France is the Research Tax Credit (CIR). It is a tax reduction calculated based on research and development (R&D) expenses incurred by companies. These expenses are, under certain conditions, deductible from the income tax or corporate tax owed by companies for the year in which the expenses were incurred.

[13] https://www.un.org/sustainabledevelopment/

[14] https://anr.fr/fr/

[15] https://anr.fr/en/france-2030/programmes-et-equipements-prioritaires-de-recherche/

This is a fiscal aid designed to support and encourage companies' R&I efforts, regardless of their domain, size, or structure. In 2021, it amounted to 7.25 billion Euro. First established in 1983, it is now a permanent measure in France. Its impact on French R&I is quite controverted despite numerous evaluations and reports; critics often underline the fact that it benefits in the first hand to the bigger firms.

As already underlined, the current French RI infrastructure is quite complex. The academic landscape is structured around universities, thematic research institutes and the CNRS – Centre national de la recherche scientific - and their research units.

Nevertheless, major shifts happened in the last 15 years, with a switch from lab-funded research to project-funded research. The National Research Agency (ANR) has thus emerged in this period as a central actor in national research strategy and funding. The French ANR is committed to supporting scientific research in general. It of course addresses “the major environmental, ecological, social, as well as digital and energy transitions our world faces”. ANR supported 1500 projects in 2023 (and roughly the same number in 2022); each project received between 100k Euro and 1.1m Euro.[16]

ANR’s funding instruments support both investigator-driven research on sustainable development through its annual generic call for projects, and project-based research through specific calls or European and international calls. ANR has its own instruments to fund international research projects and networks but also contributes to several European initiatives related to sustainable development, such as the Joint Programming Initiatives, and is involved in international initiatives like the Belmont Forum on sustainability science.

France 2030 (see above) is a massive and ambitious governmental plan that will fund R&I in general including E&S research through PEPR programs.

27 PEPR programs have been launched in various fields, including environment, health, energy systems, quantum technology, and cybersecurity. PEPR relating to CASRI topics is mentioned in Table 2-1.

ES R&I is also present on the agenda of agencies such as POPSU, ANCT, ADEME. They were created in the recent years to conduct projects with (and assist) local authorities, and help them develop innovative and ES friendly practices in their respective fields

Differently from other EU member states, France doesn’t really have a EPA. This role is then devoted to the “Commissariat général du développement durable” (CGDD) - a direction of the Ministry for Environment - and partially shared with ADEME. CGDD includes a R&I service, which mostly focuses on managing research and developments on various issues related to sustainable development without producing research itself. It encompasses a wide range of competences and disciplines, from biological research, satellites use all the way to social and human sciences. It is active at the national level, through its links with different universities and R&I institutes, but also in different arenas where the funding of research is discussed, both at national (PEPR notably) level and within European programs and negotiations.

[16] https://dataanr.opendatasoft.com/

A CASRI SRIA could be pertinent in the French context:

- to better structure cooperation between academic and non-academic actors in the corresponding fields and to strengthen the development of certain trends of research (zero-net emission, circular economy, for example)
- to provide the opportunity for a broader range of academic, public and associative actors to get involved in European programs and funding, especially in fields where French initiatives lack international dimensions;
- to provide the diverse actors involved in ES R&I the opportunity to work on a strategic agenda that would go beyond the UN SDGs and/or propose actionable research to implement them, by learning from diverse European contributions;
- to capitalize on successful actionable research projects conducted at the French but also at the European level through dissemination of examples and good practices.

TABLE 6-1 SUMMARY OF THE MAIN PEPR RELATED TO CASRI THEMES

PEPR Projects	Topic	URL
AgroEcoNum - Agroécologie et numérique	Agroecology and Digital technologies	https://www.inria.fr/fr/france-2030-pepr-agroecologie-transition-numerique
Antibioresistance	Antibiotic Resistance	
B-BEST - Biomasses, biotechnologies et technologies durables pour la chimie et les carburants	Biomass, Biotechnology, and Sustainable Technologies for Chemistry and Fuels	https://www.inrae.fr/evenements/presentation-du-pepr-b-best
BRIDGES - Résilience au changement climatique : Relier les objectifs de conservation, de développement et de coopération pour accroître la résilience au changement climatique, à l'insécurité alimentaire et aux conflits émergents	Climate Change Resilience: Connecting Conservation, Development, and Cooperation Goals to Enhance Resilience to Climate Change, Food Insecurity, and Emerging Conflicts	https://www.ird.fr/bridges-un-pepr-coporte-par-lird-une-demarche-de-diplomatie-scientifique
CPA (Cultiver et protéger autrement - ex PPR CPA)	Cultivating and Protecting Differently	
FairCarboN - Carbone et Écosystèmes Continentaux : leviers et trajectoires pour la neutralité carbone	Carbon and Continental Ecosystems: Levers and Pathways to Carbon Neutrality	https://www.cnrs.fr/fr/pepr/pepr-exploratoire-faircarbon-carbone
FORESTT - Résilience des forêts	Forest Resilience	NA
Grands fonds marins	Deep Seabed	https://www.cnrs.fr/fr/pepr/pepr-dacceleration-grands-fonds-marins
H2 - Hydrogène décarboné	H2 - Decarbonized Hydrogen	https://www.cnrs.fr/fr/pepr/pepr-dacceleration-hydrogene-decarbone
MOBIDEC - Digitalisation et décarbonation des mobilités	Digitization and Decarbonization of Mobility	https://www.ifpenergiesnouvelles.fr/breve/ifpen-et-pepr-mobidec
Ocean et Climat - Un océan de solutions	Ocean and Climate - An Ocean of Solutions	
OneWater - Eau Bien Commun	OneWater - Water as a Common Good	https://www.cnrs.fr/fr/pepr/pepr-exploratoire-onewater-eau
PLASTICS - Technologies Avancées & Analyses Socio-Economiques pour la Transition Ecologique dans le Recyclage	Advanced Technologies & Socio-Economic Analysis for Ecological Transition in Recycling	https://www.cnrs.fr/fr/pepr/pepr-recyclabilite-recyclage-et-reincorporation-des-materiaux-recycles
SAMS - Systèmes Alimentaires, le Microbiome et la Santé	Food Systems, Microbiome, and Health	https://www.enseignementsup-recherche.gouv.fr/fr/le-pepr-sams-pour-une-alimentation-saine-et-durable-94704
SOLU-BIOD - Solutions inspirées de la nature : innover avec la nature pour créer des impacts positifs pour la biodiversité, la société et l'économie	Nature-Inspired Solutions: Innovating with Nature to Create Positive Impacts for Biodiversity, Society, and Economy	https://www.cnrs.fr/fr/pepr/pepr-exploratoire-SOLU-BIOD
SousSol - Sous-Sol, bien commun	Subsoil as a Common Good	https://www.cnrs.fr/fr/pepr/pepr-exploratoire-sous-sol-ressources
SPLEEN - Décarbonation de l'industrie	Industry Decarbonization	https://celluleenergie.cnrs.fr/autres-pepr/pepr-spleen/
SVA - Sélection végétale	Plant Breeding	https://www.pepr-selection-vegetale.fr/presentation/les-acteurs-du-programme
TASE - Technologies Avancées des Systèmes Énergétiques	Advanced Energy Systems Technologies	https://celluleenergie.cnrs.fr/pepr/technologies-avancees-des-systemes-energetiques-tase/
TRACCS - TRAnsformer la modélisation du Climat pour les services Climatiques	Transforming Climate Modeling for Climate Services	https://www.insu.cnrs.fr/fr/PEPR-TRACCS
TRANSFORM - Contribuer, par une recherche transformationnelle, à l'inversion des tendances actuelles qui dégradent le bien-être humain et les conditions de vie de tous les êtres vivants sur Terre	Contributing, through Transformational Research, to Reversing Current Trends that Degrade Human Well-being and Living Conditions for All Beings on Earth	NA
VDBI - Ville durable et bâtiments innovants	Sustainable City and Innovative Buildings	https://www.univ-gustave-eiffel.fr/luniversite/nos-projets-transformants/programme-et-equipement-prioritaire-de-recherche-pepr

It is too early to assess PEPR effectiveness, as most of them just began on 2023. But they are central initiatives in mobilizing R&I towards SE topics currently in France.

6.1.2 Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
To federate initiatives in order to strengthen research, innovation and their visibility	S	Building a stronger R&I community on these issues, for broader projects and/or a better articulation with public policies	N,E
To bridge the gap between technical studies, sustainability studies and social sciences	T,A	A better circulation and development of pertinent innovations Short term	N,E

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

6.1.3 Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Use-inspired research and innovations on sustainability related issues	A Actionable research, real size experiments and "demonstrators"	To multiply local innovative and sustainable configurations for i.e. agro-food systems, waste recycling (short, medium term) Facilitate the local development of such initiatives through labs and exchange spaces (short term) Work on the articulation between local experiments and broader initiatives (demonstration through examples, dissemination of knowledge, integration into public policies) (short term)	R

Contribution to international instances (CDB, IPBES, GIEC ...) and topics discussed and framed at the EU level / pesticides, REACH ...	T Arguments and indicators susceptible of contributing to international laws and debates or to expertise	Evolution of international laws and guidance, long term project But also knowledge to be mobilized quickly for authorization / evaluation processes (short term)	E,I International negotiations and expertise
Systemic issues, resilience of societies in a context of climate change	S systemic approaches to local issues	Sustainable development (in the broader sense), long-term	R,N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

6.1.4 Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Research on behaviour (collective and individual) and social issues: Explore the interactions between user needs and interests, the relevance of available services and existing policies	T	To identify pathways for a better acceptance of public policies : improve policy adherence, reduce resistance to change, and implement more inclusive decision-making processes. (Long term)	R
Taking into account the democratic challenges related to urban changes and sustainable urbanization	S	link ecological and democratic issues to prevent future social crisis (Short term)	N

Implement continuous urban analysis and long-term observation devices	A	Monitor the evolution of urbanization to optimize urban planning, resource management, and resilience (short term) Guide cities towards a sustainable and inclusive city system. (Long term)	R

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

6.1.5 Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Limits of the current energy transition	S, T	Focus on behavioural change in energy consumption to move towards sufficiency and reduction of energy consumption (Short term)	N
Questioning technical innovations	A	How to stop / forbid innovations that consume too much energy or are not sustainable (e.g. air conditioning)? (Short term)	I

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

6.1.6 Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Regulatory and legal aspects as they have not been sufficiently explored in link with ES R&I issues	S	To implement public policy and remove eventual reglementary barriers, short term	R,N

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

6.2 Promising funding schemes

General considerations:

The different programs and institutions currently in place in France seem to leave no “big gaps” in ES R&I. Nevertheless, some research practices lack adequate funding or financing mechanisms. For instance, interdisciplinary projects and participatory science often face funding shortages. There are also challenges with integrating social sciences into interdisciplinary or participatory research projects.

Parts of the R&I on the concerned topics are financed at the national level. Contributions and participations in European programs can be quite rare in some fields and disciplines. While fundamental sciences or technology driven projects regularly rely on European projects and funding, some actors—such as social sciences academics, associations or local authorities—are less frequently involved, and sometimes unwilling to participate. This can result in some difficulties to find partners in the context of user-oriented or actionable research projects.

PEPR projects constitute one of the most dynamic funding schemes currently at the national level. Several of them work on topics directly related to CASRI and thus could be interested in further collaboration on an agenda at the European level (the list provided in Table 6-1).

Most research programs could evolve in the near future, while some of the initiatives associating researchers and local actors are still fragile. Major changes in research governance at the national level may happen very soon, with the nomination of 7 “Programming Agencies”[17] that will become responsible for research programming and funding, with the ambition to simplify the French administrative landscape.

The implication of local authorities on ES R&I is highly variable, some have built really interesting competences and partnerships with researchers. While urban studies have a long tradition of such partnerships, it is also the case when it comes to biodiversity and climate in different places (cf. the regional Intergovernmental Panel on Climate Change (GIEC) in Nouvelle Aquitaine, or the initiatives conducted by the French national parks association).

Proposals for funding improvements:

- Fund spaces for interaction and mediation between researchers (with different areas of expertise) and civil society actors to collaboratively build research projects. For example, in Bordeaux, the "Urban Forum" was established in 2015 to bring together actors from social sciences research and urban stakeholders. In France, "common laboratories" allow partnerships between companies and research labs but generally do not foster partnerships with public actors and authorities.
- Consider the costs and constraints (mostly time) associated with cooperation between a plurality of actors and researchers to ensure these collaborations can be sustainable.
- Projects associating a large variety of actors still can result in administrative difficulties as there are currently very little structures that can finance all types of partners (research units, associations, firms, local collectives ...).

[17] Those responsibilities will be given to already existing research operators : CEA, CNES, CNRS, INRAE, INRIA, INSERM. On CASRI topics, the main interlocutors will be : CEA – APED (on energy transition), CNRS – CBSD (on sustainable urbanization, biodiversity and climate), INRAE (on biodiversity and climate, circular production system**).**

- For example, funding should cover both research laboratories and local authorities (municipalities, etc.) to include territories in the project. Conversely, territories should also be able to initiate research projects that directly address their needs.

- It is essential to allocate part of the funding for the dissemination of the knowledge produced. For instance, fund researchers' participation in editorial boards of popular science journals or, more generally, fund the sharing of results with stakeholders.
- Support communities of practice within projects to improve the sharing of best research practices across European projects.
- Fund a phase for reflection and co-construction in interdisciplinary projects.
- Make calls for projects more flexible, allowing extensions beyond three years.
- During project selection, prioritize project quality over researcher excellence.

6.3 Improving the Science Practice Policy interface (SPPI)

1. Political decision-makers' disinterest in science

The general sentiment among interviewees is that there is a "complete disconnect" between political elites and science in France. This gap seems particularly pronounced in France compared to other European countries (according to interviewees who have spoken with other European actors). The political sphere lacks knowledge of basic scientific principles (e.g., the water cycle), but more critically, there is a disregard for scientific knowledge by decision-makers.

Decision-making processes often prioritize input from private actors over that of academic experts. Leveraging private sector resources is beneficial, especially in the context of public sector budget constraints. Consultancy firms could potentially act as intermediaries between science and policy, facilitate access to scientific knowledge for decision-makers and offer collaboration opportunities. However, some private actors also provide ready-made solutions to policymakers, which can limit scientists' direct involvement in certain decision-making processes.

Scientists who contribute expertise, for instance in evaluation committees, are typically those whose approaches align with the dominant paradigm and who have the time and willingness to engage. Conversely, those with divergent perspectives may be less inclined to stay involved in these bodies.

Lobbyists often wield more influence than individual scientists, as science is not a single voice: a scientist's influence partly depends on peer recognition. This context led to the creation of organizations like IPBES and the IPCC to provide a collective scientific synthesis. Generally, researchers exert limited influence on decision-makers, especially on topics deemed low-priority or when their findings oppose existing policy directions. In the short term, research has minimal impact on the national political agenda, but it tends to gain traction gradually, notably through collaboration with administrative technicians.

2. Field issues not easily addressed by research

Political actors struggle to grasp research, making it difficult to formulate pertinent questions for researchers. This issue is not only due to a lack of interest but also a shortage of skills to comprehend scientific knowledge, highlighting the need for support or training.

Although some policymakers are eager to make progress, they often lack the skills or knowledge needed to engage researchers effectively.

Generally, the research project development process is top-down: researchers choose their study topics before consulting with decision-makers. Moreover, science struggles to align with political demands due to differing time-frames: politics demands immediate results, while research requires time to develop sustainable solutions.

Research-oriented funding and projects initiated by researchers can have difficulties articulating their action with local actors and stakes. Their interactions with local authorities remain rare, as ES R&I still is not considered an operative tool by a lot of local elected officials. The sensibilization of these officials to the stakes and opportunities of locally implemented R&I strategy in the field of sustainability could appear as one option to develop interests and cooperation. The integration of further research on public policies and the effects of norms in ES R&I appear to NKS as a good leverage in order to bridge the gap between science, policy and practices.

3. Rethinking the Science-Policy interaction

Knowledge transfer through organizations like IPBES and the IPCC has promoted widespread coverage of research results, with a notable impact on French environmental policy. Nonetheless, it is essential to complement these efforts with other approaches to ensure genuine uptake of these issues by decision-makers. Reports targeting decision-makers exist, but, in a democracy, this of doesn't and shouldn't automatically mean that they are (fully) incorporated in decisions.

The challenge is to promote opportunities for exchange between researchers and local or national politicians. Co-creation of research projects with stakeholders from the start, defining topics, research questions and approaches together, could maximize impact by identifying relevant questions and the pathways needed to develop suitable solutions.

To foster constructive exchanges, it would be helpful to create regular meeting spaces between scientists and policymakers, not exclusively focused on scientific questions but rather as places for co-learning and mutual understanding. Researchers' involvement in civic movements could help bridge research and policy, though this topic is debated. Some argue that the roles of "citizen" and "researcher" should remain distinct to preserve objectivity, while others claim that objectivity is an elusive ideal.

On their part, political actors need to engage in a continuous process of interaction between "knowledge" and "actions," accounting for the guiding role of lobbies and the diversity of scientific voices, as scientists' influence varies with decision-makers. Finally, although French centralization has its critics, it also offers significant advantages, particularly in its ability to steer research over the long term with considerable and consistent strength.

Territory-oriented funding and projects initiated by local actors (local authorities, associations) often find it too difficult to fully integrate a research component. While expertise is often provided by public agencies and/or private firms, resorting to research is often perceived as complicated, time and human resources consuming or even prone to complexify issues rather than solve them. Projects initiated at the local level and including research nevertheless exist and have multiplied during the recent years (cf. for example the citizen-driven observatories of the environment, or the local "GIEC"); further studies might be conducted to better characterize the conditions of emergence of such initiatives, the convergence of actors and interests that make them happen and their impacts.

6.4 Recommendations for CASRI by NKS

To improve the situation, NKS suggested:

- Promoting “solution-oriented” research rather than «production of knowledge» *per se*, by addressing needs formulated by citizen and institutions
- Working on how to remove the obstacles to joint actions - differences in timing, differences in objectives - and how to better co-construct projects between research and society.
- Developing places of dialogue around scientific issues aimed at improving dialogue, familiarity and cooperation between actors, even at the local level.
- Moving towards other forms of steering and promoting research programmes and projects, take example from the matchmaking platform set up by the DUT partnership to facilitate the constitution of consortia: https://dut-call-2024.b2match.io/
- ES R&I involving a plurality of actors in the earlier stages is highly praised by the NKS. It is considered a condition for success when attempting to implement issue-based methods or pertinent research-action.
- There are still arguments about the most pertinent way to conceptualize R&I involving a plurality of actors: radical interdisciplinarity, transdisciplinarity, sustainability science, co-production of research ... and about the extent and systemacy of such practices.
- Co-production of research, research action and expertise activities are insufficiently valued in the current evaluation process of researchers, which is essentially based on publications in peer-reviewed journals.
- Social sciences should not be limited to acceptability, and the impacts of projects at the social, economic and political aspects should be given attention (notably when designing scientific calls on a European level).
- Reflexivity and contextualisation should systematically be encouraged in the design and conduct of R&I projects.
- Networking the major « Science for change » centres at European level.
- A researcher forum/database: to find out which researchers are working on what and how to contact them for interdisciplinary projects. This linkage must be digitized.
- Reducing the administrative burden of research programs.
- Develop cross-financing for research and socio-economic players (local authorities, associations, companies, etc.).

6.5 Reflection on the workflow

We succeeded in reaching the goal of interviewing at least 20 National Key Stakeholders (NKS). We successfully achieved a balanced gender parity. However, it is worth noting an over-representation of knowledge producers, particularly in the academic sphere. This can partly be attributed to the fact that we are a ministry and not an EPA. Our role involves steering research to support our public policies, which makes knowledge producers particularly relevant actors for us to consult when identifying France's specific needs.

The interviews generally lasted more than an hour, allowing us to explore the most important elements of the questionnaire in depth. Some participants requested to receive the questionnaire in advance so they could prepare their answers more thoroughly.

We did not use the questionnaire as provided by CASRI, as it appeared too complex to be used as such during interviews. Thus, we adapted it and focused on the most relevant items for interactions with NKS. However, when NKS wanted to receive the questionnaire beforehand, we sent them the original CASRI version.

Some NKS had limited spontaneous knowledge on specific topics like funding, networks, or R&I priorities. Some aspects, particularly funding, needed further clarification after the interviews.

Some strong opinions were moderated, and those expressed by too little interviewees were filtered out. This was intended and done to provide a report more representative of general views and to ensure that shared positions were reflected.

The complexity of French administrative architecture and the vast number of agencies and programs involved in CASRI topics at the national level appeared to be quite a challenge for the investigators. It is reminiscent of a more general issue: as mentioned earlier, the NKS themselves - including the more senior ones - have difficulties coping with this complexity.

To do the same:

- Send the questionnaire before the interviews so that the NKS can prepare.
- Hold the workshop in less than a day.
- The workshop was valuable for questioning certain elements that seemed to be widely agreed upon during the interviews, making it an important step in the process.

To do differently:

- The items requested in the questionnaire are very specific and don’t necessarily require an interview. NKS could have completed these items in advance, with the interview used to explore certain aspects further.
- The suggested workshop schedule was much too long for NKS to find time to attend to it. We chose to hold it as a half-day event, but this might have affected the content. NKS didn’t have enough time to share or develop everything that they wanted to, and the lack of cohesion led each person to focus on their own interests rather than contributing elements valuable to the project.
- Gain more clarity on the benefits for NKS in participating in the project, particularly regarding the next steps, so they feel more invested and participation improves.

7 GERMANY – National Report

Authors: Sonja Otto, Stephan Bartke, Karl Eckert, Nina Hagemann

SUMMARY IN GERMAN[18]

Forschungsbedarf zur Nachhaltigkeitsforschung in Deutschland

Die Forschungslandschaft in Deutschland zeigt einen hohen Bedarf an interdisziplinärer Forschung im Bereich der Nachhaltigkeit, insbesondere in den Bereichen Kreislaufwirtschaft, Biodiversität und Klimawandel. Es zeigt sich jedoch eine starke Heterogenität in den bestehenden Förderansätzen, welche untereinander nur schwer koordinierbar sind. Das bestehende breite Angebot an Fördermöglichkeiten steht demnach trotz hoher Nachfrage einer ganzheitlichen Umsetzung umfassender Nachhaltigkeitsstrategien hemmend gegenüber. Eine stärkere Integration von Forschung und Praxis würde Chancen bereitstellen, um die Herausforderungen der nachhaltigen Entwicklung effektiver anzugehen. Die Förderung von Querschnittsthemen wie die sozio-ökonomischen Rahmenbedingungen des Gelingens, Partizipation oder der Megatrend der Digitalisierung werden zunehmend in der Förderlandschaft berücksichtigt.

Im Nationalen Stakeholder Workshop diskutierten die Teilnehmenden, dass regulatorische Rahmenbedingungen und Governance-Strukturen vereinfacht und optimiert werden müssten, um die gesellschaftlich etablierten Widerstände gegen eine nachhaltige Transformation zu überwinden. Konsens herrschte in dem Wunsch, dass vor allem die sektorübergreifende Zusammenarbeit gestärkt werden und Silo-Denken überkommen werden müsse. Die Teilnehmenden diskutierten wie wichtig es sei, eine breitere Akzeptanz für nachhaltige Wirtschaftsformen zu schaffen und die Diskrepanz zwischen mikroökonomischen Entscheidungen und volkswirtschaftlichen Konsequenzen zu adressieren. Dazu sei unter anderem eine modernere Kommunikation notwendig.

In den vier zentralen Forschungsbedarfen von CASRI (Topics) diskutierten die Teilnehmenden auffallend oft vor allem Querschnitts-Themen.

Im Einzelnen:

Resiliente, schadstofffreie Kreislaufwirtschaft: Es besteht ein Bedarf an Forschung zu regulatorischen Rahmenbedingungen, dem Überwinden von Widerständen gegen Transformation und der Entwicklung von Infrastrukturen für die Kreislaufwirtschaft. Die Notwendigkeit optimierter Governance-Strukturen wurde als entscheidend angesehen, um sektorübergreifende Zusammenarbeit zu fördern.

Biodiversität & Klima: Der Fokus wurde auf die Implementierung und Anwendung von Forschung, internationale Klimapolitik sowie nachhaltige Landnutzung gelegt. Es wurde betont, dass alle Themen integriert betrachtet werden müssen, um Wissenslücken zu schließen und effektive Umsetzungsstrategien zu entwickeln.

[18] Der folgende Text ist eine KI-unterstützte und menschlich finalisierte Zusammenfassung der vom UBA angefertigten Kurzstudie zur Nachhaltigkeitsforschung und -förderung in Deutschland, ergänzt mit den Ergebnissen aus dem am 22.10.2024 in Berlin abgehaltenen Nationalen Stakeholder Workshop.

Nachhaltige Urbanisierung: Die Optimierung von Regularien und die Verfügbarkeit von Daten für stadtplanungsrelevante Prozesse wurden als wichtig erachtet. Die Rolle der Digitalisierung und künstlicher Intelligenz in der Stadtentwicklung wurden ebenfalls hervorgehoben.

Natur- und umweltverträgliche Energiewende: Die Forschungsbedarfe bestehen sich vor allem in der Förderung einer Transdisziplinarität, Implementierung von Forschung und der Deregulierung. Die Akzeptanz der Energiewende in verschiedenen Sektoren, insbesondere in der Industrie und bei privaten Haushalten, sei für eine Veränderung entscheidend.

Neben den CASRI-Topics wurden auch *Querschnittsthemen* diskutiert: Hier wurden vor allem die gesellschaftlichen Widerstände gegen die Transformation ganz allgemein sowie die Wechselwirkungen zwischen Wissenschaft, Politik und Gesellschaft als zentrale Herausforderungen identifiziert. Die Teilnehmer plädierten für eine Stärkung dieser Querschnittsthemen in der Forschungsförderung.

Finanzierungsmöglichkeiten der Nachhaltigkeitsforschung in Deutschland

Die Finanzierung der Nachhaltigkeitsforschung erfolgt in Deutschland hauptsächlich durch staatliche Akteure, insbesondere durch Bundesministerien wie das BMBF, BMUV und BMWK. Im Jahr 2020 stellte der Bund etwa 2,3 Milliarden Euro für Forschungsprojekte in den Bereichen erneuerbare Energien und Umwelt zur Verfügung. Zudem gibt es bedeutende Programme wie das FONA-Programm, das ein Gesamtvolumen von 4 Milliarden Euro für den Zeitraum 2021-2025 umfasst. Private Stiftungen spielen ebenfalls eine wichtige Rolle, wobei die Deutsche Bundesstiftung Umwelt (DBU) im Jahr 2022 rund 50 Millionen Euro für relevante Projekte bereitstellte.

Im CASRI-Workshop betonten die Teilnehmenden am Beispiel für die Förderung einer integrierten Stadtentwicklung die Notwendigkeit einer gemeinsamen finanziellen Planung aller Beteiligten. Es wurde betont, dass neue Akteure in Finanzierungspläne einbezogen werden sollten, um eine nachhaltige Entwicklung zu fördern.

Relevante Aspekte der Interaktion zwischen Wissenschaftspolitik und Praxis (SP(P)I)

Die Interaktion zwischen Wissenschaftspolitik und Praxis versteht sich in Deutschland geprägt von der Notwendigkeit, politische Strategien mit praktischen Umsetzungen zu verknüpfen. Die Förderprogramme sind jedoch oft an übergeordnete politische Strategien gebunden, was eine enge Zusammenarbeit zwischen Wissenschaftlern und politischen Entscheidungsträgern erfordert; mehr noch, als dass politische Strategien dazu oft an übergeordnete Forschungsprogramme gebunden sind.

Die Diskussionen im Workshop zeigten, dass es wichtig ist, die Wechselwirkungen zwischen Wissenschaft, Politik und Praxis besser zu verstehen. Der Austausch über Hemmnisse und Chancen im „Science-Policy-Practice Interface“ war ein zentrales Thema. Die Berücksichtigung sozioökonomischer Rahmenbedingungen und gesellschaftlicher Akzeptanz ist oft entscheidend für den Erfolg von Projekten. Es herrschte Einigkeit bei der Forderung, dass es dringend notwendig werde, über adäquate Förderung auch ergebnisoffen innovative Lösungen testen zu können und diese dann auch in die Umsetzung zu bringen.

Relevante nationale Aktivitäten der Nachhaltigkeitsforschung in Deutschland

In Deutschland gibt es eine Vielzahl verschiedener Förderprogramme, die sich auf spezifische Themen konzentrieren, beispielsweise Maßnahmen zur Resilienz urbaner Räume, zur Biodiversität sowie zur Energiewende.

Das *Aktionsprogramm natürlicher Klimaschutz*, mit einem Budget von vier Milliarden Euro, kombiniert z.B. konkrete Maßnahmen zur Förderung von Biodiversität und Klimaschutz. Zudem werden internationale Kooperationen gefördert, um den Austausch von Wissen und Technologien zu verbessern.

Die Diskussionen beim CASRI-Workshop hoben den dringenden Bedarf an interdisziplinärer Forschung und verstärkter Zusammenarbeit zwischen verschiedenen Akteuren in der Nachhaltigkeitsforschung hervor. Die Teilnehmer betonten spezifische Forschungsbedarfe innerhalb der CASRI-Themen und legten besonderen Wert auf die Optimierung von Vorschriften sowie die effektive Umsetzung von Forschungsergebnissen.

Angesichts der wachsenden Bedrohungen für Umweltpolitiken durch reaktionäre Kräfte ist internationale Zusammenarbeit unter Umweltbehörden in Europa von entscheidender Bedeutung geworden. Diese Behörden müssen sich vereinen, um gemeinsam ihre Errungenschaften zu verteidigen, wobei ein starker Fokus auf der Verbesserung von Kommunikation und Glaubwürdigkeit liegt. Wissenschaftler werden aufgefordert, aktiv mit der Öffentlichkeit zu kommunizieren, um Vertrauen in evidenzbasierte Politiken zu fördern, was für die Aufrechterhaltung der Legitimität von Umweltinitiativen unerlässlich ist.

Darüber hinaus erfordern wirtschaftliche Herausforderungen und Priorisierungen eine kritische Neubewertung der Förderprioritäten aufgrund schrumpfender Ressourcen. Die Akteure werden ermutigt, sich auf wesentliche Projekte zu konzentrieren und strategisch zu entscheiden, welche Initiativen gegebenenfalls verschoben werden können, um sicherzustellen, dass die begrenzte finanzielle Unterstützung effektiv genutzt wird. Dieses koordinierte Vorgehen zielt darauf ab, die komplexen Herausforderungen der Nachhaltigkeit durch gemeinsame Forschungsinitiativen und strategisches Handeln anzugehen.

EXECUTIVE SUMMARY ENGLISH[19]

Research needs for sustainability research in Germany

The research landscape in Germany shows a great need for interdisciplinary research in the field of sustainability, particularly in the areas of circular economy, biodiversity and climate change. However, there is a strong heterogeneity in the existing funding approaches, which are difficult to coordinate with each other. The existing wide range of funding opportunities is therefore an obstacle to the holistic implementation of comprehensive sustainability strategies, despite high demand. Greater integration of research and practice would provide opportunities to tackle the challenges of sustainable development more effectively. The promotion of cross-cutting issues such as the socio-

[19] The following text is an AI-supported and human-finalised summary of the short study on sustainability research and promotion in Germany prepared by the UBA, supplemented with the results of the National Stakeholder Workshop held in Berlin on 22 October 2024.

economic framework conditions for success, participation or the megatrend of digitalisation are increasingly being taken into account in the funding landscape.

At the National Stakeholder Workshop, the participants discussed the need to simplify and optimise regulatory frameworks and governance structures in order to overcome society's established resistance to sustainable transformation.

There was consensus on the need to strengthen cross-sector collaboration in particular and to overcome silo thinking. The participants discussed how important it is to create broader acceptance for sustainable forms of business and to address the discrepancy between microeconomic decisions and economic consequences. Among other things, this would require more modern communication.

In the four central research needs of CASRI (topics), the participants discussed a striking number of cross-cutting issues.

In detail:

Resilient, pollution-free circular economy: there is a need for research into regulatory frameworks, overcoming resistance to transformation and the development of infrastructure for the circular economy. The need for optimised governance structures was seen as crucial to promote cross-sector collaboration.

Biodiversity & Climate: The focus was placed on the implementation and application of research, international climate policy and sustainable land use. It was emphasised that all topics must be considered in an integrated manner in order to close knowledge gaps and develop effective implementation strategies.

Sustainable urbanisation: The optimisation of regulations and the availability of data for processes relevant to urban planning were considered important. The role of digitalisation and artificial intelligence in urban development was also highlighted.

Nature and environmentally friendly energy transition: The research needs exist primarily in the promotion of a transdisciplinary approach, implementation of research and deregulation. Acceptance of the energy transition in various sectors, particularly in industry and private households, is crucial for change.

In addition to the CASRI topics, *cross-cutting issues* were also discussed: Here, societal resistance to the transformation in general and the interactions between science, politics and society were identified as key challenges. The participants argued in favour of strengthening these cross-cutting issues in research funding.

Funding options for sustainability research in Germany

Sustainability research in Germany is mainly funded by state actors, in particular by federal ministries such as the BMBF, BMUV and BMWK. In 2020, the federal government provided around 2.3 billion euros for research projects in the fields of renewable energies and the environment. There are also important programmes such as the FONA programme, which has a total volume of 4 billion euros for the period 2021-2025. Private foundations also play an important role, with the German Federal Environmental Foundation (DBU) providing around 50 million euros for relevant projects in 2022.

At the CASRI workshop, participants emphasised the need for joint financial planning between all stakeholders, using the example of funding for integrated urban development. It was emphasised

that new stakeholders should be included in financing plans in order to promote sustainable development.

Relevant aspects of the interaction between science policy and practice (SP(P)I)

The interaction between science policy and practice in Germany is characterised by the need to link political strategies with practical implementation. However, funding programmes are often linked to overarching political strategies, which requires close cooperation between scientists and political decision-makers; moreover, political strategies are often linked to overarching research programmes.

The discussions in the workshop showed that it is important to better understand the interactions between science, policy and practice. The exchange on obstacles and opportunities in the 'science-policy-practice interface' was a central topic. The consideration of socio-economic framework conditions and social acceptance is often decisive for the success of projects. There was unanimous agreement that there is an urgent need to be able to test innovative solutions in an open-ended manner through adequate funding and then implement them.

Relevant national sustainability research activities in Germany

In Germany, there are a number of different funding programmes that focus on specific topics, such as measures for the resilience of urban areas, biodiversity and the energy transition. The Natural Climate Protection Action Programme, for example, with a budget of four billion euros, combines specific measures to promote biodiversity and climate protection. The programme also promotes international cooperation in order to improve the exchange of knowledge and technologies.

The discussions at the CASRI workshop underscored the pressing need for interdisciplinary research and increased cooperation among various stakeholders in sustainability research. Participants highlighted specific research needs within CASRI topics while emphasizing the importance of optimizing regulations and effectively implementing research findings.

In light of rising threats to environmental policies from reactionary forces, international cooperation among environmental agencies in Europe has become crucial. These agencies must unite to collectively defend their achievements, with a strong focus on enhancing communication and credibility. Scientists are urged to engage actively with the public to foster trust in evidence-based policies, which is essential for maintaining the legitimacy of environmental initiatives.

Furthermore, economic challenges and prioritisation necessitate a critical reassessment of funding priorities due to dwindling resources. Stakeholders are encouraged to concentrate on essential projects and strategically decide which initiatives can be delayed, ensuring that limited financial support is utilized effectively. This coordinated effort aims to address the complex challenges of sustainability through collaborative research initiatives and strategic action.

7.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

7.1.1. National research context

The research funding landscape in Germany is characterised by a complex network of state actors (primarily federal and state governments and the European Commission), commercial enterprises and private non-profit institutions (foundations, NGOs, associations, etc.). The majority of expenditure on research and development in Germany takes place in the business sector (as part of internal company investments) and university education[1]. In contrast, public funding calls for research projects in the four relevant thematic areas of environmental and sustainability research, which in Germany are mainly financed by state actors (especially federal ministries), are important for CASRI. In 2020, for example, the federal government provided a total of around 2.3 billion Euro for research and development in the funding areas of renewable energies and climate / environment / sustainability[2].

The state funding structure reflects the federal state structure, with the governments of the 16 federal states mainly funding university research and projects with local or regional relevance. The federal government's research funding, which is primarily relevant to CASRI, is linked to thematic guidelines or target dimensions of overarching political strategies (e.g. "German Sustainability Strategy" (DNS), "National Strategy on Biological Diversity" (NBS))[3]. In the context of funding environmental and sustainability research projects, the Ministry of Education and Research (BMBF), the Ministry of the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), the Ministry of Economic Affairs and Climate Protection (BMWK) (energy transition and climate protection topic area) and the Ministry of Housing, Urban Development and Building (BMWSB) (sustainable urbanisation topic area) should be mentioned in particular as key players. The ministries are supported by their downstream departmental research institutions (Federal Environment Agency (UBA), Federal Agency for Nature Conservation (BfN)) or so-called project management agencies (e.g. DLR Project Management Agency, Project Management Jülich) for the technical and administrative development and monitoring of the research projects funded as part of the ministerial funding programmes[4].

In the complex state funding system, a large part of the funding for environmental and sustainability research is combined in the BMBF's "Research for Sustainability" (FONA) programme with a total volume of 4 billion Euro for funding approvals in the period 2021 - 2025. This programme is a central element of the German funding landscape, as "[...] in Germany, apart from the bundling efforts in FONA, there is a great heterogeneity of funding approaches whose coordination and reference to sustainability goals has hardly taken place [...]"[5]. Another central government funding programme can be found in the BMUV's Departmental Research Plan (REFO Plan), which provides the subordinate departmental research institutions (relevant here are the UBA and BfN) with annual budgets to fund external research projects in addition to their own research. In addition to biodiversity, for which the BfN is responsible, the CASRI-relevant subject areas are the responsibility of the UBA with an annual budget share for funding approvals of around 50 million Euro, whose research strategy is set out in five-year research programmes. In addition, the UBA receives funding from the BMWK as part of the EVU and KLIFO plans for extramural research in the fields of energy transition and climate protection.

In the area of sustainable urbanisation, the BMWSB also offers numerous funding programmes in addition to general departmental research, some of which enable scientific support for urban development (for example in the form of real-world laboratories). Examples include the funding programmes Experimental Housing and Urban Development (ExWoSt), Model Projects in Spatial Planning (MORO) and Adaptation of Urban Spaces to Climate Change. Berg et al. (2023)[6] provide a more detailed qualitative survey of the state funding landscape in the field of sustainability research.

In addition to government funding programmes, private non-profit institutions in the form of foundations are also relevant players in the German funding landscape for environmental and sustainability research. According to the Association of German Foundations, there are around 23,000 foundations in Germany (as of 2020), around 15% of which are involved in environmental issues[7] - these are organised in an environmental working group within the association. According to a survey by the Federal Association (the most recent figures are from 2011), around 24% of the environmental foundations finance studies or expert reports by third parties[8] (note: only as a guide - questionable whether representative). The German Federal Environmental Foundation (DBU) should be mentioned here in particular, which approved project funding totalling around 50 million Euro in 2022 in CASRI-relevant subject areas[9] - this is roughly comparable to the UBA budget for extramural research in the same year[10]. Other large foundations, such as the Volkswagen and Mercator Foundations, also fund individual projects in CASRI topic areas to the tune of millions.

The topics identified for CASRI are considered and funded in numerous individual projects in German research funding in a variety of ways and from different perspectives. The funding measures and strategies summarised in the BMBF under FONA, departmental research by the BMUV and BMWK and additional project funding by foundations are central to this. The following sections provide a rough overview of the funded research perspectives at the level of the funding programmes. In the 1st CASRI topic area of resilient, net-zero, circular production systems, the focus of government research funding is on the circularity of industrial production processes in terms of the processing and reintroduction of raw materials and materials (such as plastics, building materials, phosphorus or (waste) water) into the cycle as well as resource-minimising product design. Another focus is on the capture and reuse of CO_2 (Carbon Capture and Utilisation - CCU) in production processes, primarily in the steel, cement and chemical industries - this creates synergetic effects with the topic of climate protection (mitigation / decarbonisation of industry). An overarching objective in this area is the further development of circular production processes against the background of economic efficiency and strengthening Germany as an industrial location of the future (keyword: competitiveness of German companies). The FONA funding programme "Resource-efficient circular economy - construction and mineral material cycles (ReMin)" and the UBA lighthouse project "Circular Economy for Electrical and Electronic Equipment (CircEEE)"[11] can be cited as examples. The technical perspective of the circular economy is supplemented by aspects of social perception and acceptance through science communication - for example as part of the Volkswagen Foundation's "Circularity in everyday life" funding programme.

Funding for the 2nd CASRI thematic field of biodiversity and climate change focuses on the one hand on basic research into the dynamics and consequences of biodiversity changes, including the relationships between ecosystems, biodiversity and climate change as well as the development of automated, comprehensive biodiversity monitoring (e.g. FONA funding measures BiodivKI and AMMOD).

On the other hand, the development and testing of concrete measures for the protection of biodiversity is being funded (e.g. Federal Programme on Biological Diversity (BfN), flanked by the FONA programme of research for the implementation of the National Strategy on Biological Diversity (F&U-NBS)). Another funding aspect of this thematic area is agenda-setting in business, society and politics in terms of the relevance of ecosystem services of biodiversity for human livelihoods (e.g. FONA measure BiodiWert). In the context of biodiversity as a basis for human life, projects that consider the direct effects of biodiversity changes on human health are also funded (FONA BiodiHealth). A central government funding programme that brings together the problem areas of biodiversity and climate change is the Natural Climate Protection Action Programme (funded by the BMUV and managed by the BfN). With a total budget of 4 billion Euro, the programme aims to create a synergetic effect between climate protection and biodiversity through natural sinks (forests, moors, urban green spaces, etc.). However, the majority of the budget is used to promote specific measures - only a fraction is allocated to action area 9 "Research and capacity building"[12], which funds knowledge transfer for the implementation of measures on site and their scientific monitoring as well as individual research projects (e.g. Wadden Sea research) (reference is also made here to research funding on biodiversity and climate protection as part of FONA).

Furthermore, there are direct overlaps with the 3rd CASRI thematic field of sustainable urbanisation, in which aspects of biodiversity are also considered in the context of sustainable urban development (e.g.: ÖSKKIP project, which is funded as part of the FONA measure F&U-NBS). Another key funding area is the perspective of climate adaptation, which aims to optimise resilient urban planning to protect people and infrastructure from relevant climate impacts (heat islands, drought, heavy rainfall, etc.) (e.g. FONA measure WaX). Projects are also funded that explore holistic concepts for the efficient organisation of key resources such as water, land, energy or urban greenery in sustainable urban development (e.g. FONA measure RES:Z). Furthermore, efficient and needs-based mobility (within and between urban centres) is considered as part of sustainable urban development (e.g. MobilitätsWerkStadt 2025). Here, too, there are cross-references to climate protection (mitigation in the transport sector) and social/health issues (noise protection)[13] (particularly within the framework of the UBA 2023 - 2027 research programme) through the perspective of emission-free mobility. Socio-economic and political dimensions, for example in the form of innovative governance and participation structures in sustainable urban development, also complement the more technical perspectives of the funding structure for sustainable urban development (e.g. FONA measure Sustainable transformation of urban spaces - socio-ecological research).

With regard to the 4th CASRI topic area of the energy transition, it should be noted that the FONA strategy only considers the further development and practical establishment of hydrogen technology (which is less relevant for CASRI with a focus on renewable energies). On the government side, this topic is mainly covered by the departmental research of the responsible BMWK[14] and private funding (e.g. DBU funding topic 6: Renewable energy, energy conservation and energy efficiency). The focus here is primarily on the efficient expansion and design of electricity grids and markets (particularly against the backdrop of the integration of fluctuating renewable energies) as well as on the problems of expansion and competing land utilisation for various forms of renewable energies. Further aspects of the funding landscape in the area of the energy transition are the consideration of environmental compatibility as well as social perspectives of acceptance and participation in the expansion of renewable energies.

Given that the CASRI topics are key transformation challenges, the political and social context in terms of socio-economic framework conditions, social cohesion, acceptance and participation is considered across the board in research funding (as described in the relevant sections). Furthermore, the megatrend of digitalisation, including the use of artificial intelligence, is also of great importance in the context of CASRI and can be identified as a cross-cutting perspective between the thematic fields. For example, the use of artificial intelligence is being promoted in the area of the circular economy in sustainable product design or in the optimisation of recycling processes, in the area of automated biodiversity monitoring or also in the area of urban development in the intelligent organisation of resources (e.g. water/wastewater network). The need for large (digitised) databases and corresponding computing capacities is also part of the cross-cutting topic of digitisation, for example in the promotion of complex modelling of the relationships between biodiversity and climate, the creation of digital twins in urban development or the exact modelling of extreme weather effects on urban infrastructure.

Another cross-cutting topic can be identified in the perspective of the Global South and the promotion of corresponding research networks. For example, international research collaborations with countries in South America and Africa on the interactions between social and ecological systems (including biodiversity) or on the efficient/circular use of raw materials are funded. On the other hand, it is noticeable that Germany is only very reluctantly involved in funding transnational European projects via the major funding programmes. Occasionally, for example, this happens via EU HORIZON co-financing in the area of transnational mobility or sustainable urban development.

Sufficiency is another potential cross-cutting issue that has not yet been significantly reflected in the German funding landscape.

7.1.2. Resilient, net-zero, circular production systems

On basis of the interviews, the expert group and participants discussed the following topics as identified research needs, prioritised in descending order of priority: Regulatory framework and policy, resistance to transformation, infrastructure for the circular economy, socio-ecological transformation, as well as sustainability consulting and markets and substitution and bio-based resources.

Above all, resistance to innovation and sustainable economic forms was discussed, such as the difficulties in breaking the path dependencies of existing systems and creating acceptance for innovations such as electromobility. Particular emphasis was placed on the urgency of optimised governance structures to facilitate cross-sector cooperation. Clear roles for the state and companies and the integration of mechanisms such as true pricing were seen as crucial. At the same time, strategies for overcoming resistance to transformation were identified as important. The need to make sustainable forms of business more attractive was emphasised. Promoting acceptance in society, politics and business was seen as a lever for normalising sustainable technologies and practices. The discrepancy between microeconomic decisions and their economic consequences was also emphasised. It was criticised that consumers and companies often make decisions that seem simpler but are uneconomical. One example cited was farmers' preference for cheap soya from South America over domestic animal feed.

The panellists also considered it important to take a more integrated view of infrastructure research. In addition to the expertise of specialist planners, this must also consider the needs of citizens and lobby groups in order to create appropriate, scalable infrastructure systems that are themselves designed to be sustainable.

The order of the R&I Priorities is based on the priority points these received in the workshops.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Governance and Policy Implementation Clear and optimized governance structures are essential to accelerate the transition to circular and net-zero production systems. Research must address political and institutional resistance, true pricing mechanisms, and integrated policies for cross-sector collaboration. Urgent to "normalize" sustainability, align incentives for circularity and support exnovation of non-resilient, non-circular production systems.	S, T, A	<10 years: Clear frameworks and recommendations for successful stakeholder collaboration, improved regulation. >20 years: Stable, inclusive governance fostering sustainable production systems.	R, N, E
Resistance to Transformation Resistance to new technologies and sustainable practices hinders circular economy efforts. Research must uncover causes of resistance and develop strategies to increase societal, political and economic acceptance. Urgent to reduce barriers and incentivize circular behaviours.	T, A	<10 years: Enhanced understanding of social resistance and develop strategies to promote acceptance of new products, technologies and practices. >20 years: Societal acceptance integrated into political discourse, policy and circular practices.	R, N, E, G
Circular Economy Infrastructure Circular economy relies on appropriate, scalable infrastructures for collection, recycling, and reuse. Research on enabling these infrastructures to be sustainable themselves (e.g., modular, reusable) and accessible is critical. Key lever for widespread adoption of circularity principles in production and consumption.	S, A	<10 years: Creation of experimental spaces, pilot projects at different levels. >20 years: Fully circular infrastructures supporting businesses and citizens.	R, N

Research is to identify and facilitate infrastructures at various levels.			
Socio-ecological Transformation A socio-ecological economic shift is essential for achieving, net-zero, climate and circular economy goals. Research is needed to clarify roles (public-private), develop multi-dimensional strategies, and integrate adaptive transformation paths. Crucial for mainstreaming circular practices beyond niche applications.	S, T, A	<10 years: Clarification of responsibilities and shared visions. Defined roles and pathways. >20 years: System-wide resilient and sustainable economic structures are widely established.	N, E
Sustainability Consulting and Market Creation Unlocking markets for sustainability consulting can address barriers in circular economy adoption and up-scaling. Creating demand for expert advice, backed by pilot programs, accelerates the adoption of sustainable practices. Key for companies transitioning to circular and low-carbon systems.	T, A	<10 years: Development of nascent markets for sustainability consulting. >10 years: Robust sustainability consulting landscape integrated into business ecosystems.	R, N, E
Substitution and Biobased Materials Replacing linear used critical mineral and fossil resources with biobased or regenerative alternatives is vital to reduce dependency and improve sustainability. At the same time, provision of biobased materials is considered and monitored to be sustainable (e.g. soil use). For non-substitutable materials (plastics, batteries), circularity strategies are critical. Supports low-carbon, resource-efficient production systems.	S, T, A	<10 years: Increased use of biobased materials in production. >20 years: Full integration of biobased resources in production systems, where circularity is limited.	R, N, E

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7.1.3. Biodiversity and climate

On basis of the interviews, the expert group and participants discussed the following topics as identified research needs, prioritised in descending order of priority: Implementation and application of research, international climate policy and diplomacy, sustainable land use, including forestry, climate neutrality as well as development and consideration of pathways from an environmental perspective, how to act and integrated water (resource) management.

The individual topics were considered relevant, but it was emphasised that they must always be considered together (keyword integration). It was considered important that we as a society must get into action and transformation, especially with regard to the questions of where knowledge gaps still exist and what would be the right way to implement them. Due to scarce resources, it is important to pool resources and to network and prioritise topics. Co-operation between environmental agencies can pave the way for avoiding downstream problems from the outset. Successful policy implementation should be done from an environmental perspective and consider different pathways (e.g. policy pathways, technology pathways, stakeholder analysis). The dichotomy of regulation vs. market needs should be considered. It would be helpful to develop governance approaches and forms of financing in the sense of ‘promoting and demanding’.

The order of the R&I Priorities is based on the priority points these received in the workshops.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Implementation and application-orientation of research Feasibility and transfer of climate research are highly urgent. Adaptation to climate change requires a paradigm shift away from risk assessment towards the implementation of concrete measures. The design and implementation phases must be considered together. Research projects should focus more on how innovative concepts for adaptation can be realised. This research has the potential to support implementation and create acceptance for measures.	S, T, A	<10 Development of practical adaptation strategies to support the socio-ecological transformation in relation to the economy; strengthening of implementation and implementation research (applied research) as well as consulting. >10 Infrastructures and societies are resilient to climate change.	I, E, N
International climate politics and diplomacy In a globalised world in times of climate change, environmental and climate policy must be an integral part of international diplomacy. Cooperation with formats such as BRICS, G7 and G20 is crucial to create the political framework for a sustainable transformation and to mobilise civil society support. Research needs should focus on the evaluation of success criteria.	S, T, A	<10 Development of a Theory of Change to improve international cooperation. >10 The foundations for an effective global environmental and climate policy have been laid.	I, E, N
Sustainable land use, including forestry The promotion of sustainable land use practices, considering land use competitions and thinking about land use issues together, is crucial for the preservation of biodiversity and the reduction of CO2 emissions. Agricultural research should be demand-oriented and take incentive systems into account, for example to answer the question of how sustainable demand can be organised to reconcile both economic and ecological sustainability. All relevant stakeholders (in the forestry sector, for example, not only large forest owners but also small private forest owners) from different sectors should be involved. Supposedly	S, T, A	<10 Implementation of sustainable integrated land use and forest management practices >10 Biodiversity is preserved and long-term CO2 storage is guaranteed	N,R

marginal issues such as paludiculture and the acceptance of production methods on lowland moorland should be included.			
Climate neutrality (transdisciplinary and cross-thematic) Germany and the EU are still a long way from achieving ambitious targets. At the same time, the nexus must be considered. Research in the areas of CO2/eco-balancing for products such as cellulose or bioplastics with the aim of CO2 assessment / zero-waste assessment, pollutant balancing can contribute to this. Freedom from corruption/manipulation/plagiarism protection.	S, T, A	<10 Applied research to improve the methods of CO2/eco-balancing for various product groups, including innovative ones. >10 The climate neutrality targets have been achieved.	I, E, N
in WS newly added topic: **Developing and looking at pathways from an environmental perspective** Policy implementation as a research task to get a clear idea of what is the right way for applicable implementation. This must be played out from an environmental perspective using the regulation vs. market dichotomy. To this end, various paths should be analysed, as the World Bank does, for example: it looks at policy paths and technology paths and conducts a stakeholder analysis.	Not specified	Not specified	Not specified
in WS newly added topic: **How to come into action** We already know a great deal in many areas, but the question is how do we get into action, into transformation? What is the right way to implement this? Looking at economic implications, strengthening of acceptance research: Where do we still have gaps in our knowledge? Do we know enough to be able to make recommendations?	Not specified	Not specified	Not specified

Integrated Water(resource)management A sustainable water supply is crucial for coping with climate change. Strategies for heat development require a differentiated approach to water as a scarce resource with different water requirements and qualities. Integrated water management across all types of use (industrial, urban, agricultural, ecosystem) promotes synergies and enables sustainable resource utilisation. Coordinated management improves the resilience of ecosystems.	S, T, A	<10 Applied research to improve water quality and resource use, e.g. through projects such as the model city of water or the creation of water-related urban climate models that include health concepts for heat/cooling, heat and cold storage or microclimate modelling. >10 Sustainable water use and management in urban and rural areas.	I, but trickling down to lower levels

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7.1.4. Sustainable urbanisation

Based upon the interviews, the expert group and participants discussed the following topics as identified research needs, prioritised in descending order of priority: optimisation or reduction of regulations/reporting obligations without lowering environmental standards, availability and analysis of data for processes relevant to urban planning, digitalisation and data management, integrated urban development from the perspective of different specialist disciplines as well as integrated water management, the role of the EU and EPAs in urban transformation, municipal obligations and financing.

It was discussed that artificial intelligence and digitalisation have the potential to change established areas of sustainable urbanisation. More data on sociological topics should be collected to better react to social vulnerabilities, among other things. The need for feedback between digitalisation and overarching (specialist) strategies and concepts was emphasised.

The need for research in the field of integrated urban development lies in the identification of synergies at national, state and city level. An important prerequisite for successful research is the joint financial planning of integrated urban development measures. The municipalities' ability to act for sustainable urban development must be ensured through appropriate and stipulated municipal duties and funding. Important or new stakeholders must be included in the preparation of financing plans.

The order of the R&I Priorities is based on the priority points these received in the workshops.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Regulation Existing regulatory patterns influence how sustainable urbanisation can be implemented and consolidated. Research should be carried out on the optimisation possibilities such as deregulatory governance, reduction of norms and standards (especially in construction and spatial development) and integration of relevant legislation for sustainable urbanisation.	S, T, A	<10 Concentrate regulations, reduce redundancies. >10 Full integration of relevant regulations and laws to enable sustainable urbanism.	N, R
Digitalization and Data Management Digitization is becoming increasingly important due to new data analysis methods. Good data literacy among municipalities enables sustainable decision-making in urban planning. This is particularly important for city administrations and planning authorities to design sustainable and adaptable cities. There is a research deficit of data that adequately depicts social change in relation to the ecological question: for example, sufficiency in the field of mobility, architecture.	S, T, A	<10 Utilize digitization to better understand and react to extreme weather management. Develop better access to socio-spatial data and information (according to international examples). Achieve better data management to reduce/optimize duties associated with digitalization. >10 Reflect, understand impact of digitalization on socio-political power structures in urban processes. Reflect, understand how digitalization influences disciplines, administrative duties.	N, R
Integrated Urban Planning The consideration of the impact of different disciplines and sectors of urban planning on each other (e.g. transport, services of general interest, urban greenery, water, heat planning) is important for sustainable urban development, municipal climate protection and climate adaptation in cities. Many disciplines are making strides towards more sustainability.	S, T, A	<10 Further define the goals of integrated urban planning between disciplines. Developed integrated financial planning within ministries, administrations. Integrate current transition trends to identify optimization and/or cost saving measures >10 Identify and deconstruct existing barriers to integrated sustainable urbanism.	E, N, R

Synergies between the several sectors are to be identified and trade-offs (including land use competitions) to be better understood.			
Water Management Integrated water management strategies are necessary to meet the challenges of heat and water scarcity in urban areas and to improve the quality of life in cities. Through differentiated use of water resources across types of use, cities (as well as regions) can be made more resilient. In addition, the water-energy nexus is important for resilient, emission-neutral and circular emission systems. The potential areas of conflict between sustainable urbanisation and integrated water management should be better understood. low priority, wasn't discussed at the WS	S, T	<10 Research on and integration of various water demands and quality standards (rain, drinking, used) Secure cooperation between researchers and utility companies. >10 Holistic strategies and concepts for the water-energy-nexus are widely implemented.	N, R
Roll of the EU and EPAs in the urban transformation In its role, the EU has an important role to play in setting up initiatives and transferring examples of urban transformation. EU initiatives such as the New European Bauhaus promote creative approaches to sustainable architecture and urban planning (integration of ecological, social and aesthetic dimensions). The added value is particularly great for architects, urban planners and decision-makers, as innovative solutions to the challenges of urbanisation are sought. Such EU activities have an impact on international transformation and environmental policy, which must also be redesigned and specified for the period after 2030. low priority, wasn't discussed at the WS	S, T, A	<10 Funding of innovative construction projects. Delineation of sustainability goals and agendas for time after 2030 – target audience defined communication. *>10* Establishment of a new sustainable architectural standard. Increased commitment to national and global sustainability goals.	I, E, N

in WS newly added topic: **Stipulated Municipal Duties** The duties stipulated by law which must be carried out by municipalities has impacts not only on how a topic is addressed by municipal stakeholders but also ensures that financing must be made available for the completion of these duties. For this reason, the legal and financial repercussions of such designations should be better understood. Further, the relation of the thematic goal (e.g. sustainable urbanisation) to the means with which to achieve that goal (e.g. stipulated duties) has to be quantified so that decision and policy makes can evaluate options. low priority	S, A	< 10 Full overview of relevant structure and competencies of EU and national institutions and optimize for specific goals of sustainable urbanism. > 10 Understand the impact of new stipulated duties on the actual achievement of goals, develop long term support structures for such duties to be anchored in everyday duties.	E, N, R
in WS newly added topic: **Financing** For sustainable urbanisation is it important to generate new partnerships to facilitate the wide spread adaptation of pilot project. New partnerships with financial institutions, which up until now have not played a central role for urban planning manners, may be a necessary approach moving forward. The potential of these new partnerships has to be better understood as well as the type of organisations which may be and are interested in cooperation. low priority	S, A	< 10 Understand/support insurance stakeholders as implementing and financing partner of sustainable urbanism. Utilize data for research purposes. Achieve better prioritization of environmental actions in times of stressed municipal and national budgets. > 10 Develop better incentive models to support sustainable urbanism (possibly with new partners and institutions) e.g. revolving cost savings generated from sustainable urbanism actions for further actions.	N, R

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7.1.5. Nature & environmentally friendly energy transition

On basis of the interviews, the expert group and participants discussed the following topics as identified research needs, prioritised in descending order of priority: Transdisciplinarity, implementation and application of research, deregulation and reduction of bureaucracy, as well as land use, sustainability consulting and markets, water management, foresighted planning, technology assessment and success stories and disruptive technologies, hydrogen technologies and innovations.

The discussion focussed at length on the challenges and acceptance of the energy transition in various sectors, especially in private households and medium-sized companies. Business and industry are particularly affected by the energy transition, so their acceptance would be crucial to its success. There seems to be a great deal of uncertainty in private households, e.g. regarding of whether gas heating systems have a future or should be replaced. In contrast, heavy industry is mainly weighing up how high the production costs are compared to international competitors such as China and India. The acceptance of an energy and heating transition therefore also depends on the economic viability and the incentives for the population and the economy. The participants see an urgent need for comprehensive and, above all, independent advice and support for the various stakeholders with a focus on SMEs and local authorities. The successful digitalisation of the economy through 'Industry 4.0' could be used as a best practice. A similar process could be a good driver for the energy transition. The role of advisory centres such as the European Climate Foundation and the German Energy Agency (Dena) as well as environmental agencies should be emphasised for independent, science-based information.

Furthermore, socio-ecological resistance should be considered. It was urged to establish new forms of dialogue with the involvement of communication sciences. It is intrinsically important to understand and honestly communicate the social and economic effects of the energy transition.

The order of the R&I Priorities is based on the priority points these received in the workshops.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Transdisciplinarity Implementation of an integrated system approach on energy transition. Environmental assessment across all research and policy fields requires the knowledge on who the relevant stakeholders are, what they require and what barriers they face. Complex systems of integrated research need to be designed. For example, energy transition is more than just CO_2 optimisation, the nexus of the overall systems must be considered systemically and integrate heat management, water management, power sufficiency and much more.	S, T, A	<10: It is known who the stakeholders are. All practice partners are more closely involved. There are comprehensive concepts for possible funding of research and application (e.g. RES:Z, BMBF: Energy, Water, Land & Green). >10: A sustainable SRIA is in place and is being utilised. New systems for mobility or energy have been introduced.	R, N, E, I
Implementation & realisation The connectivity of research to the market, i.e. transfer opportunities, must be established . This requires transparency and a good structure for exchange. More applied research and consulting are needed.	S, T	<10: The 'economic architecture of transformation' has been researched and compares scenarios for market regulation, e.g. with incentives. >10: Regulation and carbon pricing are linked, concrete research has created policy instruments for access to markets or. for leaner regulation.	N, E
Deregulation, reduction of bureaucracy Regulatory patterns should be optimised and made easier to understand.	S, T, A	<10: Deregulatory governance is present in the concept. Policy instruments allow simplified promotion. Norms and standards, particularly in construction and spatial development, are reduced. Environmental, building and mining laws are integrated. Small-volume applications and consortia also have a chance of funding. >10: The research and funding landscape is clear and accessible. A variety of applicants and consortia are eligible for funding.	R, N, E, I

Land use Research on concepts for overcoming land use competition.	*S. T*	<10: Incentive systems and synergy opportunities are created. >10: Dual utilisation concepts are in place.	S, T
Markets for sustainable consulting Sustainability and environmental consulting is crucial to support the transformation of the energy transition. There is a lack of structural approaches to increase the demand for independent and science-based consulting. The added value is particularly high for SMEs and public institutions and municipalities, as they need support in implementing sustainable practices.	A	<10: The need for counselling has been conclusively identified. Development and promotion of new independent and well-founded advisory services has been created. >10: A functioning market for environmental counselling is established.	R, N, E
Example: heat transition The implementation of the heating transition as an important part, perhaps the most important part, of the energy transition should be accelerated. The added value is high for households and companies (lower energy costs / reduce emissions).	S, T	<10: Pilot projects for the heat transition and coupling with the energy transition have been implemented. 'Turnarounds' are thought of as systemically linked. >10: CO_2 emissions in the heating sector are noticeably reduced.	N, E
Water management Different types of use and quality requirements of water must be recognised (drinking/grey/rain), strategies for heat development are linked. Was not prioritised at the WS, topic fits better with urbanisation, but is a cross-cutting issue.	S, T, A	<10: Technical processing and management has been researched. >10: Energy savings are measurable.	R, N
Foresight Sustainable development after 2030 must be thought through and planned today. Cost-benefit/implementation/non-implementation must be clear and robust.	S, T, A	<10: Synergetic concepts and scenarios are available and communicated. >10: Existing support programmes have been created or existing ones adapted.	N, E

Technology assessment Success stories must be told in order to convince people. This is closely related to counselling if visible successes can be used to derive: 1. this can be done, 2. YOU can do this. This must be concrete for the user. The effects of action vs. inaction become tangible.	S, T, A	not recorded	R, N
Hydrogen technologies Producing hydrogen from (industrial) waste seems promising as no incineration or toxins are required. These technologies could be scaled up quickly to drive the energy transition. Added value especially for industry and start-ups that rely on sustainable energy sources	S, T	<10: First projects for hydrogen production from waste have been funded. >10: Energy reduction potential is noticeable.	N, E
Disruptive technologies and innovations The promotion of start-ups and new technologies is central to a successful energy transition. Innovation instruments must take greater account of the CO_2 effects of research. This is particularly important for investors and policymakers, who must set the course for sustainable innovation approaches.	S, T, A	<10: Support and financing for new start-ups, even without high equity capital, is more accessible.	not recorded

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

7.1.6. Other themes / crosscutting themes

On basis of the interviews, the expert group and participants discussed the following topics as identified research needs, prioritised in descending order of priority: Resistance to transformation, Consideration of science, politics and society (SPPI), socio-ecological transformation, as well as integrated environmental assessment, land use & sustainable resource management.

The cross-cutting topics of sustainability research represent a significant challenge, as they are difficult to prioritise and often require better integration and usability of data through to research results, contrary to widespread silo thinking. For this very reason, the participants argued in favour of a general strengthening of the cross-cutting topics mentioned in research funding. Nevertheless, the participants prioritised research on resistance to transformation, whereby this was seen more as an accompanying research topic to sustainability research. Acceptance research should be avoided, rather the reputation of science should be strengthened. The participants argued in favour of a stronger implementation of the research format of real-world laboratories as a solution approach.

The participants also support this with the topic area ‘Science policy and society’. The proposed participatory research approaches met with general approval, even if their practical implementation has only been partially successful to date. New formats should be developed and trialled, such as the so-called ‘social labs’. Science should be geared towards incorporating its findings into politics and gain flexibility in this regard. Environment and sustainability must become campaignable and take up the concerns of people in science.

The integrated environmental approach was given a lower priority, as successes have already been achieved in this sector. Positive approaches are seen in research on socio-ecological transformation. Integrated research into the role of the economy, society and the state could make it possible to develop a common goal and guiding principles. Practically realisable projects could be integrated into research funding in real-world laboratories, for example through cooperation with specialist ministries.

Although less prioritised, the participants pointed out that solutions to land use conflicts are still unsatisfactory, including at European Union level. Criticism of the common agricultural policy and its impact on soil protection was at the forefront. Research deficits had already been identified in the. Inspiration research agenda (2019). Further needs were seen in the deepening of multicoded land use and land policy. The circular economy is also becoming increasingly important in view of more fragile supply chains and the current structural change.

Another current problem is the lack of preparation of research for often hasty political deregulation, which can lead to inconsistent and ineffective reforms. In conclusion, a better exchange and stronger cooperation at European level was called for.

The order of the R&I Priorities is based on the priority points these received in the workshops.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Resistance to transformation Analysing resistance to sustainable transformation helps to formulate effective policies that address resistance. It is critical to understand the social and political factors that inhibit change in order to develop robust, accepted solutions. The needs and fears of opponents must be identified, understood and actively addressed. Attractive campaigns are needed.	S, T, A	<10 Improve understanding of political resistance and its influence on policy implementation >10 Resilient policies are in place and are widely accepted by society.	N, E
Science, politics and society The close link between science and politics must be intensified. An honest understanding of blind spots in science and their influence on politics is necessary. This reflection promotes informed and participatory policy-making based on scientific findings.	S, T, A	<10 Improved communication between science and politics. >10 A dynamic and integrative system for knowledge production and utilisation is established in the long term.	N, E
Socio-ecological transformation The socio-ecological transformation is the basis for a sustainable future. The roles of business, society and the state need to be clarified and a common vision needs to be developed. The added value lies in the creation of effective structures and understandings based on ecological and social perspectives.Acceptance research is necessary. The reputation of science is an important basis.	S, T, A	<10 Clarity about stakeholder roles and development of common objectives. Real-world laboratories are established. The transition from design to doing has been successful. The issues of the population have been identified and addressed. >10 The sustainable integration of objectives into all areas of society has been realised.	R, N, E
Integrated environmental assessment The widespread implementation of an Integrated Environmental Assessment is crucial for systematically analysing the interactions between the environment and policy. It is also important to create a common understanding across different stakeholder groups. This supports decision-making at regional, national and international level.	S, T, A	<10 Building infrastructure and awareness for integrated environmental assessment. Fragmentation in the approach has been overcome. A multi-layered approach has been established. >10 Integrated standards for environmental assessment at various levels are established in the long term:	N, E, I

Land use and resource management The effective utilisation and management of resources, particularly in the area of land use, are central to sustainable development. Incentive systems to promote sustainable land use are necessary in order to create synergies and minimise conflicts of use.	S, T, A	<10 Development and implementation of incentive systems for sustainable land use. >10 Sustainable and integrated land use systems involve all stakeholders.	R, N, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

7.2 Promising funding schemes

Below the summary of current German funding schemes is given. The most effective funding schemes show reflection on their effectiveness, others are named for the sake of completeness:

Relevant Funding Schemes	Level[20]	Most relevant? Why?
Horizon Europe (EU) – Strategischer Plan	Europa	The most influential programme through the integration and networking of the volume and orientation, it is the best platform for science and research. financially strong and well-founded, diverse programme which also influences national activities. very influential because of the huge amounts of funding and because the Commission is very important. Very influential due to the favourable funding conditions and long-term orientation.
LIFE - Programm 2021-2027	Europa	most relevant for most NKS, however lower proportion of research - funding rather than research
Forschung für Nachhaltigkeit (FONA)	National	Provides a centralised framework for framework for sustainability research. FONA has been further developed towards strategic descriptions, but NCPs are unsure whether the programme is a good model/example. Still: Important for applicants, to review the eligibility criteria. Very influential agenda at national level. Focus on socially socially relevant topics, on social and ecological issues with a strong focus on implementation and increasingly also a demand for inter- and transdisciplinarity.
FEdA - Forschungsinitiative zum Erhalt der Artenvielfalt	National	innovative research topics are allowed
Deutsche Nachhaltigkeitsstrategie	National	Central German frame of reference for sustainable development and R&I to support it
Nationale Strategie zur Biologischen Vielfalt	National	irrelevant
Bundesprogramm Biologische Vielfalt	National	Both in terms of volume (promotion) as well as the focus on the natural environment, it has immense national impact, also in international comparison. Lighthouse character!
Aktionsprogramm Natürlicher Klimaschutz (ANK)	National	Both in terms of volume (promotion) as well as the focus on the natural environment, it has immense national impact, also in international comparison. Lighthouse character!
Zukunftsstrategie Forschung und Innovation	National	relevant
Nationale Bioökonomiestrategie	National	
Nationale Klimaschutzinitiative (National climate protection initiative)	National	strongly application-oriented - has a far-reaching impact on cities
Energieforschungsprogramm (BMWK)	National	in Germany is important due to its large budget volume and because it is designed to be cross-departmental. However difficult framework conditions, difficult to access as an actor.

[20] Regional [R] / National [N] / European [E] / International [I]l

Territoriale Agenda	Europa	
Programm zur Nationalen Stadtentwicklung	National	
Leitbilder der Raumordnung	Regional	
Working Programme of the Urban Agenda for the EU (UAEU)	Europa	
European Science Foundation (ESF)	Europa	
European Cooperation in Science and Technology (COST)	Europa	offers networking opportunities that are not are not included in the other programmes
Twinning-Projekte als Teil von Horizon Europe	Europa	
Nationale Wasserstrategie	National	Specifies fields of action and prioritises prioritisation of the types of use.
Europäische kommunale Abwasserrichtlinie	Europa	
neue Förderrichtlinie zur Dekarbonisierung in der Industrie im Rahmen der Bundesförderung Industrie und Klimaschutz (BIK)(BMWK)	National	
Hydrogen-Strategie	National	
langfrist negativ emmissions strategie	ab 2025	
Carbon management strategie (CMS)	2025	
Biomasse-Strategie (in Planung)	National	expected 2025
Umweltinnovationsprogramm (UIP)		

Recommendations (after the workshop) to setup the funding for the CASRI SRIA

Please note: all answers below are generated with the help of AI. The basis consists solely of the answers out of 30 interviews and the Stakeholder Workshop.

The most frequent topics raised by the interviewees can be categorised into several key areas:

Interdisciplinary collaboration between the social and natural sciences was named several times to be from importance for the sustainable transition. The interviewees emphasise that an interdisciplinary approach is crucial in order to clarify fundamental questions about the relationship between society and the environment. It is emphasised that humans should not just be seen as a disruptive factor, but should actively intervene in biophysical processes and change them. This perspective requires a new research agenda that involves both environmental and educational institutions as well as acting Stakeholders that are able to realise new findings.

The interviewees argue for specific and clearly defined thematic agendas within funding programmes. They argue that the more clearly defined programmes are, the more useful they are, as general approaches are often diluted by compromises. The SRIA should include clear objectives and resources to drive the discourse on appropriate indicators and monitoring mechanisms.

The representatives see the upcoming 10th EU research framework program in particular as an important instrument for guiding national funding programmes. It is emphasised that a good political programme at EU and national level is crucial in order to target funding.

The interviewees emphasise that smaller stakeholders often find it difficult to navigate the challenging and complex funding landscape. They often lack the human and financial resources to successfully apply for funding. Comprehensive funding could help to establish these structures and facilitate access. Some suggestions were made to increase the funding rate to over 100% in order to also promote capacity building in smaller interest groups.

Improving collaboration with stakeholders is seen as essential. A co-design approach could help to better understand hidden motives and decisions and to develop relevant indicators. The need to establish suitable indicators and monitoring mechanisms is particularly emphasised in the area of Education for Sustainable Development (ESD).

Finally, there is a call for application-oriented programmes. The interviewees agree that the programmes should be tailored to the needs of target groups such as NGOs and civil society actors. The transfer of basic research into application-oriented projects must be improved in order to successfully implement technologies.

Summarized (CASRI) thematic areas that are currently *not* covered sufficiently by funding:

A large number of research gaps were mentioned. A central aspect was the need for integrated and systemic approaches. Integrated environmental assessment, a focus on implementation, a holistic view of transformation processes and nexus approaches such as the water-energy nexus were prioritised.

An important focus is on the social dimension of sustainability. Here, dealing with resistance to transformation, inequality and justice in relation to environmental issues as well as adult education in the field of Education for Sustainable Development (ESD) are mentioned. These aspects emphasise the need to take greater account of social factors in sustainability research. Thus the socio-ecological transformation of the economy and the involvement of society in transformation processes, are also identified as important fields of research. Another important area concerns administration and financing, emphasising the modernisation of public administrations and the development of strategic investment planning for municipalities.

The implementation and practical orientation of research is also identified as an important area. The aim here is to close the gap between research and practice, involve practice partners more closely and promote participatory research approaches. The promotion of experiments and real-world laboratories is also considered important. In the area of urban transformation and urban development, topics such as sufficiency and resource-efficient urban neighbourhoods, climate change and adaptation in cities and water management in urban areas are identified as urgent fields of research, particularly with regard to climate neutrality and coping with extreme weather events. In the area of water and resource management, a differentiated approach to scarce resources is called for, including research into grey water and rainwater utilisation.

The role of digitalisation and technology in the sustainability transformation is named as an important cross-cutting topic in connection with sustainable transformation and thus an important field of research.

In addition, the promotion of experiments and cooperation between research and society, the strengthening of participation in sustainability, including for marginalised groups, as well as addressing resistance to transformation and questions of inequality and justice in the context of environmental issues.

Promising (new) funding schemes or collaborations that CASRI could use or look at for ideas.

From NKS as relevant named collaborative funding schemes:

EU Programmes with associated Partners, COST, ESF, FONA/ANK (mehrere Ressorts beteiligt), Europäische Partnerschaften, Belmont Forum, Collaborative Research Actions, BMDV Behördennetzwerk, Agora Energiewende/Agora Verkehrswende/Agora Agrar (gute Anschubförderung), Mercator Stiftung, Deutsche Bundesstiftung Umwelt, Interreg, Urbact, „Die Energieeffiziente Stadt“ (BBSR mit KfW-Bank, Kommunen wurden eng mit einbezogen), Real-Labor-Forschung (KIT und Wuppertal-Institut), A.SPIRE Processes4Planet (Research Association, aspire2050.eu), SPRINT, European Climate Foundation, SEQUOIA & CIFF finanzieren größten Teil des Overheads, JPI-Climate AXIS, Volkswagen, Biodiversa.

Key Demands from NKS concerning successful collaborative funding schemes:

For collaborative funding to be successful, it is crucial that all partners have a genuine interest in the projects, especially in institutionalised partnerships, in order to avoid deadweight effects. A targeted selection of partners with overlapping interests can help to increase efficiency and define objectives more clearly, as partnerships that are too large run the risk of being inefficient.

There is a constant trade-off between the need for focussed work on specific topics and the need for systemic thinking that takes complex, overarching issues into account. In order to facilitate innovative research processes and create scope for creative solutions, open forms of funding should therefore be made available. Reducing the administrative burden by standardising requirements can facilitate cooperation. The need to co-finance overhead costs poses a major challenge and can jeopardise the sustainability of projects. Equal access to funding is essential, as the quality of collective knowledge suffers if one partner receives the majority of funding and others are only marginally involved.

Transnational and interdisciplinary projects should be budgeted for at an early stage in order to secure funding. Pioneers in new technologies should be specifically supported in order to drive innovation. The formation and support of networks should be actively promoted in order to improve knowledge transfer and public relations.

Successful collaborative research funding requires a balanced mix of strategic planning, flexible use of funds and a strong partnership basis to effectively address research challenges. It should have several key features to be effective:

1. partnership structure

Genuine self-interest: Successful partnerships require strong self-interest on the part of the institutions involved, particularly in the case of institutional partnerships, to minimise deadweight loss.

Diversity of partners: The choice of partnership type should be based on potential impact. Fewer partners with clear objectives enable focussed work, while larger partnerships are often more complex and less effective.

2. strategic orientation

Focussing vs. systemic thinking: There is a trade-off between specific focus topics and a systemic approach. A clear thematic embedding is crucial to foster collaboration.

Strong leadership: One or more funding organisations should take the lead to define common goals and steer collaboration.

3. flexibility in the use of funds

Open funding: The ability to use funds freely is important for innovative research processes. Funding organisations such as the Volkswagen Foundation or DFG offer more freedom in this respect.

Equality of partners: All partners should act on an equal footing in order to promote pluralistic knowledge and not allow only one dominant perspective.

4. administrative efficiency

Simplified administrative processes: The administrative burden of managing funding should be minimised to facilitate collaboration. Different requirements of the funding organisations can be a hindrance.

Co-financing: One challenge is institutional funding, which often requires co-financing for overhead costs.

5. Interdisciplinarity and international co-operation

Interdisciplinary projects: These are particularly effective for knowledge transfer and public relations. Early consideration of such projects in the budget could facilitate funding.

Networking: The promotion of networks is crucial for the success of collaborative research projects as it supports exchange and co-operation between different actors.

6. innovation funding

Freedom for research: Innovative knowledge requires freedom in the research process, which is better possible with institutions such as the Volkswagen Foundation or DFG.

Support for first movers: Support for pioneers in new technologies should be guaranteed.

Justifications essential to persuade national funders to join a cross-national funding initiative[21]:

Participation in a new funding agenda offers numerous advantages for donors, which can be clustered into several key categories.

One of the primary benefits is the opportunity for international networking and cooperation and thus and the exchange of experiences among stakeholders. Donors can leverage existing contacts and formats, such as European partnerships, and engage with relevant funding organisations from various countries.

[21] AI Perplexity has summarised the following statements from the interviews. The aspects mentioned first were mentioned by several NCPs.

This collaborative environment fosters stronger connections and enhances collective efforts. Another significant advantage lies in the potential for increased efficiency and the creation of synergies. By pooling resources, donors can achieve a greater impact than they could individually. This collaborative approach allows for the sharing of experiences from other countries, enabling participants to tackle more complex issues that would be challenging to address alone. Donors will also benefit from enhanced visibility and profiling. Participation in this initiative raises awareness for sponsors and helps sharpen their profiles within international networks. Additionally, it provides a platform for presenting innovative solutions, such as through solution labs, further elevating their presence in the field. From a political and strategic perspective, donors gain advantages by connectivity to existing funding lines while establishing new focal points. This alignment with their own research policy priorities supports their efforts in achieving broader political goals, such as climate targets.

Beyond these primary advantages, several secondary benefits also emerge:

Joint communication efforts directed at governments can facilitate better implementation of initiatives. This promotes a productive exchange between science, policy, and practice, ensuring that insights are effectively translated into action. This topic can be paraphrased as Knowledge Transfer and Implementation. The collaborative work on complex topics generates added value through innovation. Participants can develop scalable knowledge derived from detailed expertise, leading to practical solutions that address pressing challenges.

Finally, there are economic considerations to consider such that collaboration presents potential scaling opportunities and avenues for return on investment. Possibilities for co-financing large EU projects, can help maximizing financial resources and impact.

In summary, engaging in this new funding pot not only enhances the effectiveness of donors but also strengthens their networks, visibility, political alignment, and economic potential.

7.3 Improving the Science Practice Policy interface (SPPI)

Summarize how the main / designated organizations are facilitating the interaction between science, policy and practice:

Examples: The DLR (German Aerospace Center) acts as a bridge between science, policy, and practice by implementing funding guidelines and establishing research programs. It engages in science communication to support dialogue among stakeholders, ensuring research findings are effectively relayed to policymakers.

UBA (Federal Environment Agency) plays a crucial role in promoting sustainability and environmental protection by facilitating multi-stakeholder platforms that include industry representatives and civil society. It organizes dialogues with various sectors to discuss sustainability challenges, emphasizing the need for flexible approaches to address evolving topics.

The DBU (German Federal Environmental Foundation) comprises a board that includes representatives from science, policy, practice, and civil society, fostering a collaborative environment for decision-making. Thus, it focuses on integrating policy advice into projects and ensuring that outcomes are communicated effectively to relevant stakeholders.

The German National Sustainability Platform engages in regular exchanges with scientific actors and offers guidance on securing funding for sustainability initiatives. It hosts events that connect researchers with policymakers to promote the application of scientific knowledge in practical settings.

Summarised, the NKS' active involvement with SPPI was described as follows:

Facilitation mechanisms

Organizations frequently host conferences, workshops, and informal meetings, i.e. Networking Events, to foster relationships among scientists, policymakers, and practitioners. These gatherings allow for the exchange of ideas and best practices.

Collaborative Projects between academic institutions and governmental bodies are encouraged to ensure that research is aligned with policy needs and practical applications. This collaboration often includes public engagement strategies to raise awareness of project outcomes.

Effective communication strategies are emphasized as a critical component of interaction. Organizations utilize various formats such as reports, guidelines, and multimedia content to disseminate findings and recommendations tailored to different audiences.

Many organizations advocate for adaptable frameworks and flexible structures that can evolve with changing topics and stakeholder needs. This flexibility allows for the integration of new ideas and technologies into ongoing discussions about sustainability and environmental governance.

Challenges identified

There is a recognized need for improved science communication, particularly regarding climate change and biodiversity issues, where public understanding and engagement are crucial.

The bureaucratic landscape poses challenges to implementing effective policies based on scientific findings; thus, reducing red tape is essential for better integration of science into practice.

The diversity of topics and personalities involved in decision-making processes requires tailored approaches to foster mutual understanding between scientists and policymakers.

Summary of the main challenges and suggestions for reinforcing or improving the SPPI and who should take action.

The interaction between science, politics and practice plays a central role in the day-to-day work of the interviewees and is promoted by a wide range of activities and organisations. Several focal points and patterns can be identified that emphasise the complexity and importance of this exchange.

One key aspect is the variety of communication and exchange formats. These range from formal events such as conferences, workshops and parliamentary evenings to informal one-to-one discussions and network meetings. Digital formats such as websites, videos and possibly podcasts are becoming increasingly important. The importance of personal contacts and informal exchanges at various events is particularly emphasised.

Networking and cooperation between the sectors is promoted by various structures. These include networks, cooperation projects with administrations and scientific institutions as well as advisory bodies such as project advisory boards and boards of trustees. These structures enable continuous dialogue and promote mutual understanding.

Knowledge transfer and counselling play a key role in the interaction. Research results are fed back into politics, committees and departments are advised and project results are communicated to specific target groups. The creation of guidelines and recommendations for action serves the practical implementation of scientific findings.

Public relations work and the dissemination of results are carried out through various channels. Large events, exhibitions and trade fair presentations are used to make project results accessible to a wider audience. Transfer to industry associations or standardisation is also mentioned as an important aspect.

The international and, in particular, European dimension is gaining in importance. Initiatives such as 'DBU goes Brussels' bring relevant national topics to the European level. Exchanges in EU bodies and committees are considered important in order to reach agreements at an early stage and avoid national solo efforts.

Structural aspects such as flexibility in project organisation and breaking down silo thinking are cited as important factors for successful interaction. The creation of platforms for exchange is seen as necessary in order to facilitate cooperation between the sectors.

Despite the wide range of activities, challenges and needs also became clear. There is a desire for greater mutual understanding between the sectors, clearer communication and more transparency regarding the motives of the various players. The understanding of different processes and timeframes is also seen as needing improvement.

The interaction between science, politics and practice is considered to be extremely important and is promoted through a variety of formats and activities such as networking, knowledge transfer and target group-orientated communication. The main challenges lie in mutual understanding and overcoming barriers between the areas. Flexibility and adaptation to specific project needs are seen as the key to success.

The main challenges and suggestions for reinforcing or improving the Science-Policy-Practice Interface (SPPI) have been identified through various discussions among stakeholders. Here's a summary of these challenges and the recommended actions:

Main challenges

Insufficient Science Communication: There is a pressing need for enhanced science communication, particularly regarding climate change and biodiversity issues. Current funding cuts have hindered efforts in this area, leading to a lack of clarity about the roles individuals can play in these initiatives.

Bureaucratic Barriers: The implementation of sustainability measures is often hampered by bureaucratic red tape. Streamlining processes and embracing digital solutions are essential to improve efficiency.

Diverse Stakeholder Engagement: Engaging with a wide range of stakeholders, including different personalities and sectors, presents challenges. There is a need for flexibility in how organizations approach these interactions.

Lack of Coordination Across Sectors: There are gaps at the intersections of sustainability with economic and social topics, which require cross-sector collaboration to address effectively.

Need for Multi-Stakeholder Platforms: Current frameworks lack sufficient platforms that facilitate collaboration among various stakeholders, including industry, academia, and civil society.

Understanding Organizational Cultures: Different ownership structures within companies influence their willingness to engage in sustainability transformations, necessitating tailored approaches for engagement.

Suggestions for improvement

Strengthening Communication Efforts: Organizations should prioritize science communication initiatives to articulate the importance of climate action clearly and encourage public involvement.

Streamlining Bureaucracy: Efforts should be made to reduce bureaucratic hurdles and enhance digital processes to facilitate quicker implementation of sustainability initiatives.

Fostering Flexible Workforces: Agencies like UBA (Federal Environment Agency) should develop flexible workforce strategies that allow employees to adapt to emerging topics and engage with new challenges effectively.

Establishing Multi-Stakeholder Platforms: Creating independent platforms that bring together diverse stakeholders can enhance collaboration and ensure that various perspectives are represented in decision-making processes.

Encouraging European Collaboration: Early coordination on topics relevant at the European level can prevent isolated national efforts and foster broader support for initiatives across member states.

Engaging New Talent: Attracting new employees who understand both scientific and economic perspectives will be crucial for advancing sustainability goals.

Building Trust Through Dialogue: Establishing round tables and networks that involve community representatives can help build trust and ensure that large-scale questions are defined collaboratively.

Who should take action:

Government Agencies: Institutions like UBA should lead efforts in enhancing communication strategies, reducing bureaucratic barriers, and fostering multi-stakeholder platforms.

Research Institutions: Academic entities must engage actively in policy dialogues and contribute to effective science communication to bridge gaps between research findings and practical applications.

Industry Leaders: Companies should recognize their role in sustainability efforts and participate in collaborative initiatives that align with environmental goals.

Civil Society Organizations: NGOs can facilitate dialogue among diverse stakeholders, ensuring that community voices are heard in policy discussions.

In summary, there are a number of challenges: the need for better communication and practice-oriented research, political fragmentation, difficulty in mobilising knowledge, and the shortage of skilled workers. Stronger networking between research, practice, and politics, as well as better consideration of regional and social conditions, is urgently needed.

7.4 Recommendations for CASRI by NKS

Based on the interviews:

The recommendations focus on different aspects of the research and innovation agenda, with networking, interdisciplinary collaboration and the promotion of disruptive innovation being particularly emphasised. The interface between science, policy and practice as well as flexible and user-centred approaches are also considered important.

Networks and co-operation

1. Promote long-term networks
   - Tools to create long-term networks (more than 2-3 years)
   - Support communities of practice
   - Collaborative research involving all eligible countries
2. Interdisciplinary and cross-sectoral cooperation
   - Inclusion of cross-cutting issues such as sport, tourism and culture
   - Consideration of consumption and sufficiency
   - Focus on space and land use as an important cross-cutting area

Innovation and transformation

1 Promote disruptive elements and start-ups
   - Support for small companies and newcomers with disruptive technologies
   - Promotion of start-ups with potential for decarbonisation and nature conservation
2. Flexible and dynamic processes
   - Allowing short-term changes in long-term strategies
   - Iterative approaches in the research and innovation agenda

Science-policy-practice interface

1. Strengthen practical orientation
   - Focus on the application of knowledge and innovations in practice
   - Validation through UBA involvement instead of direct references to other countries

2 Policy advice and regulation
   - Influence on policy regulations
   - UBA/CASRI as a role model for regional/local authorities

Other important aspects

- Considering ethical and moral criteria in research and business
- User-orientation instead of a pure focus on technology
- Inclusion of underrepresented groups, especially young people and young adults
- Data generation and knowledge processing as important areas

- Establish “independent innovation agencies”, as e.g. modelled by the Z.U.G. GmbH
- Strengthen the European research landscape with a view to research and policy advice

Funding options

- Recognise the complexity of funding and design
- Utilise thematic federal funding with sustainability components
- Consider European funding opportunities such as Horizon Europe / FP 10

Additional recommendations

- Consider context specificity in different countries and disciplines
- Use co-design approaches for joint product development
- Allow multiple consortia with different approaches in joint calls

Based on the workshop:

One of the main findings from the workshop discussions was perhaps that the cross-cutting issues identified took up a lot of space. In the CASRI topics, too, the experts primarily discussed cross-cutting issues and how these could be broken down into topics.

There was a consensus that cross-cutting issues should be the focus of further research with a view to the frequently called for transdisciplinary research and how barriers to the success of a sustainable transformation could be overcome. These could act as a superstructure for the research question. Below this, i.e. also at a subordinate level, the CASRI topics should be investigated as exemplary use cases within the framework of the overarching cross-cutting topic.

As overarching principles, i.e. cross-cutting issues, intra-disciplinarity, socio-ecological transformation, governance and implementation, international climate policy and diplomacy, digitalisation and data management, deregulation and the reduction of bureaucracy were identified.

Closing Discussion of Workshop:

International co-operation between environmental agencies

International co-operation among environmental agencies in Europe is seen as increasingly important, especially in the face of growing attacks on environmental and sustainability policies by reactionary and far-right forces. These threats come not only from extreme political parties, but also from broader social movements that seek to undermine environmental policy achievements. The need to stand together and take joint action against these attacks is emphasised. It is recommended that the path of co-operation and communication with European partners be consistently pursued in order to overcome the challenges and defend environmental policy.

Importance of communication and credibility

Improving communication is a key aspect of co-operation. It is no longer enough to simply publish scientific papers or give specialised lectures; scientists must actively engage with the public and clearly defend their convictions. This is crucial for the credibility and legitimacy of evidence-based policy. Encouraging all stakeholders to engage with the public and communicate their views proactively is seen as necessary to strengthen trust in scientific evidence and safeguard the reputation of environmental policy.

Economic challenges and prioritisation

The economic environment for environmental projects has deteriorated, requiring a critical reassessment of priorities. Falling tax revenues and the general economic downturn pose a challenge as fewer financial resources are available. It is advisable to focus on the essentials and reprioritise. This applies to both research funding and the implementation of projects. Stakeholders are called upon to strategically weigh up which measures are urgently needed and which can be postponed if necessary in order to do justice to the limited resources.

Ideas regarding the use of any (transnational) pooled budget for the scope of CASRI:

What is recommended to consider in setting up/governing future funding option(s) for the CASRI SRIA so that the expected impact can be achieved?

(Question 12 from interviews)

Analysing the statements on future research funding reveals several key issues. One central aspect is networking and cooperation across different levels, including overcoming policy silos and involving smaller players and NGOs. A stronger focus on implementation and application is also called for, with concrete, usable results taking centre stage. Transparency and clear objectives are considered essential, as is the early involvement of relevant stakeholders and affected parties in the research process. A recurring theme is the desire to reduce bureaucracy and simplify processes in order to facilitate access to funding.

The proposed improvements aim to make research funding more flexible, practical and inclusive. It is emphasised that research projects should pursue transdisciplinary goals and be accompanied by systematic monitoring. The digitalisation of administrative processes and more generous funding for implementation partners without regular institutional funding are mentioned as important steps. Overall, there is a need for research funding structures that go beyond the traditional academic framework and address the gaps in existing programmes in order to increase the effectiveness and relevance of research.

7.5 Reflection on the workflow

As said above, one of the main findings from the workshop discussions was perhaps that the cross-cutting issues identified took up a lot of space. In the CASRI topics, too, the experts primarily discussed cross-cutting issues and how these could be broken down into topics. There was a consensus that cross-cutting issues should be the focus of further research with a view to the frequently called for transdisciplinary research and how barriers to the success of a sustainable transformation could be overcome. These could act as a superstructure for the research question. Below this, i.e. also at a subordinate level, the CASRI topics should be investigated as exemplary use cases within the framework of the overarching cross-cutting topic.

As overarching principles, i.e. cross-cutting issues, intra-disciplinarity, socio-ecological transformation, governance and implementation, international climate policy and diplomacy, digitalisation and data management, deregulation and the reduction of bureaucracy were identified.

It was rarely an issue for the NKS, both during the interviews and the WS, whether identified research needs where to be classified as actionable, transversal or systemic knowledge. It was also difficult to steer the discussions in this direction. The general interest was always in the topics themselves and how they could be linked or realised. The experience from Germany therefore shows that such a categorisation may not be important for further considerations.

A comprehensive list of existing support schemes and SRIAs in Germany and Europe was compiled during the preparation of the desk study. Only minor additions were made by the NKS.

We have sorted the CASRI TOPICS tables according to their priority in the workshop and have therefore added a column in each table to show the number of adhesive points assigned (as a prioritisation tool).

Reflection on the workflow from the perspective of the NC:

How representative, reliable and complete is the collated information;

- Good representation. Of course number of interviews is limited, but for the purpose we achieved to reach out with relevant experts that have good overview and insights.
- The National Workshop was a milestone to ensure reliability of the collated info in the interviews and desk study. The Workshop confirmed rather then added topics. The workshop did not disagree to collected information.
- As the number of participants in the interviews and national workshop was limited, it is not possible to assess the completeness of the picture for certain. We send an extensive report of the workshop also to all interviewees that could not join the workshop to give opportunities to.

What has been removed and added during the different steps and why?

- We used the guiding questionnaire. Only in some interviews, elements where not used in cases where an expert had no expertise in a specific area or field (e.g. financial instruments)

What are main differences in result between desk study, interviews and workshop?

- Desk study: Focus on status quo. Topics on Bioeconomy, Hydrogen, …
- Interviews: Where structured having in mind the 4 thematic areas of CASRI while broader / transversal topics were mentioned under others or across the topics. In the Workshop those topics became more and more the first layer of orientation with the CASRI thematic areas becoming a second layer.

What would you do the same and what would you do differently when it comes to the workflow if you had to do it all again?

- The flow was fine, we struggled with getting the stuff on board in time. This made it very challenging for us. Given an early on involvement, the procedure would have been fine. Maybe more buffer time is needed to ensure better coping with unforeseen challenges.
- We particularly appreciate the efforts of WP 2 Leaders. Regular information and follow-up of actions. Preparation and joint discussion of templates and experiences in executing the tasks has been very good.

- Of course, if more resources would have been available, a broader survey, interviewer base and deeper assessment would have been possible. Maybe we were able to do a reasonably sound 80-20, which is a good use of resources and should be a sound basis for the next steps in CASRI.

8 IRELAND – National Report

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EXECUTIVE SUMMARY

Ireland's Research and Innovation Strategy, Impact 2030, strongly recognises that R&I are critical enablers to support delivery of our climate action targets and address wider environmental and sustainability challenges. It sets out that addressing climate change is a fundamental, complex and multi-faceted issue for society, and is intrinsically linked to a range of environmental and sustainability challenges and commitments, including transforming our energy and food systems, creating a circular economy and bioeconomy, ensuring we have clean air, water and soils, protecting and restoring our biodiversity and adapting our society and infrastructure to climate change impacts.

The EPA Research Programme is focused on delivering essential scientific support for environmental policy development, implementation and broader decision making. Its strategy, EPA Research 2030, is designed to be agile, responsive and flexible to changing policy contexts and needs. It is structured around four thematic hubs: (1) Addressing climate change evidence needs; (2) Facilitating a green and circular economy; (3) Delivering a healthy environment; and (4) Protecting and restoring our natural environment. The EPA Research Programme is also responsible for coordinating environmental research in Ireland and facilitates this through the National Environmental Research Coordination Group (NERCG).

On a three-year cycle, the EPA undertakes a comprehensive assessment to identify thematic research priorities, with the most recent Thematic Research Priorities 2024-2026, published in July 2024. The 37 priorities identified were informed by in-depth review of national and international strategies, plans and policies, extensive national consultation, which included written responses from over 260 stakeholders as well as direct bilateral engagement with national key stakeholders, followed by a further synthesis of feedback to finalise the priorities. This consultative process is well aligned with that proposed in the CASRI project.

The priorities outlined in the National Report for Ireland are closely based on those in the EPA Research Priorities 2024-2026. The priorities and impacts reflect those within or related to the remit of the EPA and are focused primarily on addressing evidence and knowledge gaps to inform future policy, so do not represent all R&I priorities in Ireland. Additional interviews with National Key Stakeholders were undertaken to validate these priorities, include additional priorities, and to obtain further perspectives on the science to policy interface and national funding schemes.

In regard to funding options to address environmental and sustainability research agendas, the national key stakeholders identified the following areas, which are described in more detail in the document, as being important:

- Collaborative funding approaches are seen to be very effective, both those that support researchers to collaborate but also where funding agencies engage in collaborative co-funding initiatives;
- Support for blue-skies research must be retained and balanced with applied research to ensure that new and novel ideas can be explored;
- Additional supports are required for inter- and trans-disciplinary research;
- Opportunities and fora to bring together researchers, policy makers and other experts are important;
- Additional and sustained funding is needed across the research system in Ireland, and this must ensure that all domains have opportunities to access funding.

The knowledge transfer landscape is evolving quickly and growing in importance both nationally and internationally. The national R&I strategy Impact 2030 places a strong focus on building stronger connections between the R&I and policymaking systems and improving the accessibility and uptake of publicly funded research by policymakers. The EPA Research Programme has a strong track record in engaging with relevant stakeholders throughout the research project cycle, from the initial pre-award steps of identifying knowledge gaps to inform research calls and evaluating high quality, impactful research projects, through to facilitating active participation by relevant stakeholders in project Steering Committees, and finally the dissemination of research outputs at project completion.

In addition, during the interviews with the National Key Stakeholders, the following themes came through:

- Accessibility to the outputs from all research projects needs to be improved;
- Early engagement between the research and policy communities is crucial for effective knowledge transfer;
- More opportunities for engagement should also be considered, such as networks, conferences, and other fora;
- Capacity building to raise awareness in the research and policy communities of the potential for knowledge transfer but also their respective needs and constraints;
- Additional supports should be provided for communications and dissemination activities.
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8.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

8.1.1 National research context

Ireland's Research and Innovation Strategy, Impact 2030, strongly recognises that R&I are critical enablers to support delivery of our climate action targets and address wider environmental and sustainability challenges. It sets out that addressing climate change is a fundamental, complex and multi-faceted issue for society, and is intrinsically linked to a range of environmental and sustainability challenges and commitments, including transforming our energy and food systems, creating a circular economy and bioeconomy, ensuring we have clean air, water and soils, protecting and restoring our biodiversity and adapting our society and infrastructure to climate change impacts. In 2024, the Department of the Environment, Climate and Communications launched its Research & Innovation Strategy to 2030, which further sets out the importance of R&I in informing and underpinning the green and digital transitions and aims to fully harness the potential of R&I to achieve our national and international ambitions. Since 2023, Ireland's annual Climate Action Plan includes a dedicated chapter on R&I, further emphasizing the commitment to R&I in addressing climate and sustainability objectives.

There are a significant number of Government Agencies and Departments in Ireland that provide competitive funding for R&I related to climate, the environment and sustainability. These include Research Ireland, the Environmental Protection Agency (EPA), the Sustainable Energy Authority of Ireland (SEAI), the Department of Agriculture, Food and the Marine, the Geological Survey of Ireland (GSI), Met Éireann (the Irish Meteorological Service), the Marine Institute, amongst others, all of which also have their own research strategies and priorities informed by their specific remits. Funding agencies regularly engage in co-funding arrangements to support research projects of mutual benefit.

The EPA in Ireland differs from analogous agencies in other countries, including those participating in the CASRI project, in that it runs its own research funding programme. This is underpinned by its research strategy and priorities, which inform its activities, including its competitive funding programmes, international and EU partnerships, management of a significant portfolio of awards and proactive knowledge transfer. The EPA Research Programme is focused on delivering essential scientific support for environmental policy development, implementation and broader decision making. Its strategy, EPA Research 2030, is designed to be agile, responsive and flexible to changing policy contexts and needs. It is structured around four thematic hubs: (1) Addressing climate change evidence needs; (2) Facilitating a green and circular economy; (3) Delivering a healthy environment; and (4) Protecting and restoring our natural environment. It is noted that there is alignment between the EPA's research hubs and a number of the CASRI thematic areas.

The EPA Research Programme is also responsible for coordinating environmental research in Ireland and facilitates this through the National Environmental Research Coordination Group (NERCG). The main purpose of the NERCG is to provide a cross-sectoral, national forum for the strategic coordination of environmental research in Ireland and consists of approximately 40 Public Organisations involved in Environmental Research.

On a three-year cycle, the EPA undertakes a comprehensive assessment to identify thematic research priorities, aligning with the nation's strategic research and innovation agenda, with the most recent Thematic Research Priorities 2024-2026, published in July 2024. The 37 priorities identified were informed by in-depth review of national and international strategies, plans and policies, extensive national consultation, which included written responses from over 260 stakeholders as well as direct bilateral engagement with national key stakeholders, followed by further synthesis of feedback to finalise the priorities. Consultation was focused on the research community (knowledge providers; 73% of respondents) and policy makers and implementers (knowledge users; 26% of respondents), with other knowledge users such as NGOs making up the rest.

The EPA process for identifying priorities aligns strongly with the proposed CASRI process, as well as being well aligned with the timelines for the National Comprehensive Review. As such, the National Comprehensive Review for Ireland has primarily been informed by the work undertaken by the EPA for its assessment of research priorities. A number of additional interviews with National Key Stakeholders from the academic and research community were conducted; these were not part of the bilateral engagements undertaken for the Thematic Research Priorities. While the EPA's Thematic Research Priorities are well aligned with the aim of CASRI to develop a Strategic Research and Innovation Agenda (SRIA) for EPAs across Europe, it is noted that the priorities set out in this comprehensive review are limited to those within the remit of the EPA in Ireland, which, for example, does not include the energy transition or urbanization as key elements of our research programme. Other agencies in Ireland have primary responsibility for these areas.

As mentioned above, Ireland strongly recognises that R&I are critical enablers to support delivery of our climate action targets and address wider environmental and sustainability challenges. As such, the EPA, but also the wider environmental research community, will view the development of the CASRI SRIA with interest. It may inform the identification of potential needs and opportunities for research nationally, but also to support for further engagement with the European Research Area, in which the Irish research community is actively engaged and receives national support. The EPA in Ireland will promote the SRIA through its role in coordination environmental research in Ireland.

8.1.2. Resilient, net-zero, circular production systems

As mentioned in the introduction, the priorities outlined here are closely based on those in the EPA Research Priorities 2024-2026, identified through a significant consultation process. The priorities and impacts reflect those within or related to the remit of the EPA and are focused primarily on addressing evidence and knowledge gaps to inform future policy, so do not represent all R&I priorities in Ireland.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Integration of the circular economy, climate and biodiversity Half of greenhouse gas (GHG) emissions and 90% of biodiversity loss are due to resource extraction and processing. Decoupling economic growth from resource use and transitioning to a circular economy and bioeconomy is key to achieving net-zero GHG emissions by 2050 and restoring biodiversity.	S, A, T	Improved implementation of an integrated approach to addressing climate change, biodiversity loss and the transition to the circular economy. Effective assessments of the role of the circular economy and bioeconomy in the mitigation of climate impacts and biodiversity loss in Ireland, and to better understand trade-offs and synergies between sectors and policy areas. Short term <10 years	N, E, I
Enhancing the assessment of materials, products and value chains in the circular economy in Ireland. Consideration of the whole life cycle – from design, extraction, importation, production, consumption, recovery and end of life – is required to develop sustainable products, services and business models. Assessment of materials, products and by-products in key product value chains (textiles; food, water and nutrients; plastics; packaging; electronics; construction and buildings; and batteries and vehicles) is necessary to capture the flow materials and to assess their environmental impacts (intended and unintended).	S, A	New assessment methodologies to analyse how circular materials, products and systems can go beyond the net zero goal of doing no harm and can have positive ecological, economic, and social impacts. Short term <10 years	N,E

Supporting and scaling up the just transition to the circular economy As we transition to a sustainable society, we must ensure that this is done in a just and equitable way as this pertains to job creation, elimination and substitution, industrial transformation, and ensuring equity in accessing and benefitting from the opportunity of this transition.	A, T	Mechanisms and initiatives to accelerate the transition to the circular economy, to enable knowledge transfer and capacity building, while also considering the potential socio-economic impacts and gender vulnerabilities of the transition at local and regional level and in rural and urban areas. Short term 10 years	N, E
Developing metrics and indicators of progress to circularity Ireland currently collates and reports various statistics under the EU Circular Economy Monitoring Framework, but significant sectoral, material and economic data gaps still exist.	A	Sectoral and material metrics and indicators to measure and monitor the impact (intended and unintended) of circular economy polices and instruments during Ireland's just transition to circularity. Short term <10 years	N, E
Designing innovative sustainable products, value chains and managing materials using digital technologies Digital technologies can help to develop innovative products, circular business and collaborative consumption models to accelerate circularity and dematerialisation and the use of virgin raw materials.	A	Sustainable products that are more durable, more efficient and easier to repair and recycle will become the norm in the EU. Digital technologies will enable the development of sustainable products through innovative eco-designs, sustainable value chains and industrial symbiosis. Initiatives such as the digital product passports, tagging and watermarks, will facilitate traceability, market surveillance and material management along the key product value chains (textiles; food, water and nutrients; plastics; packaging; electronics; construction and buildings; and batteries and vehicles) Short term <10 years	N, E

Material flow analysis to support the transition to a circular economy and Bioeconomy It is essential that the flow of materials in our economy is captured to support the transition to a circular economy and sustainable bioeconomy and improve self-sufficiency.	T	Analysis to identify potential supply and demand gaps in key material flows and product value chains, during the transition from virgin raw materials use (e.g. fossil fuel-based carbon) to secondary raw materials (e.g. sustainable carbon) use, reuse and repair. Short term <10 years	N, E
Towards zero pollution To achieve targets set out in the EU Zero Pollution Action Plan, there is a need for more progress in reducing transport noise, excess nutrients and persistent chemicals in freshwater and marine ecosystems and waste, as well as needing to address key emerging issues including hazardous chemicals and soil pollution.	A	Intensified monitoring, measuring, mapping and to prioritise pollution risks, to identify and enact solutions and to measure their impact. Research is needed to resolve, quantify, and prioritise the impacts of known and emerging pollutants and to explore potential solutions. Short term <10 years	N
Chemicals and Materials that are Safe and Sustainable by Design (SSbD) The full extent of the occurrence/use of hazardous chemicals is not fully understood, particularly in industry, products, and waste. The EU Chemicals Strategy for Sustainability promotes the use of safer and more sustainable chemicals and materials through the Safe and Sustainable by Design (SSbD) framework.	T	Transition to chemicals that are SSbD and adoption of innovative and co-ordinated regulatory approaches to support and promote the use of chemicals that are SSbD. Short term <10 years	N, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

8.1.3. Biodiversity and climate

As mentioned in the introduction, the priorities outlined here are closely based on those in the EPA Research Priorities 2024-2026, identified through a significant consultation process. The priorities and impacts reflect those within or related to the remit of the EPA and are focused primarily on addressing evidence and knowledge gaps to inform future policy, so do not represent all R&I priorities in Ireland. Those indicated with an asterisk have been added following NKS interviews.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Supporting nature, ecosystems and biodiversity in our waters With greater species loss in aquatic, rather than terrestrial habitats recorded on a global scale, solutions for multiple benefits are required, specifically in the context of National Water, Climate and Biodiversity Action Plans.	*S, A*	Improved monitoring, evaluation, and prediction tools for multiple pressures, along with application of novel solutions such as green/blue infrastructure, ecological engineering and ecohydrology for restoration of vulnerable ecosystems, species and habitats. Medium term > 10 years	N, E
Sustainable management of water resources – water quantity In the context of a changing climate and increasingly frequent storm and drought events, resilience, adaptation and mitigation to hydroclimatic extreme events is critical to support infrastructure, livelihoods and lives.	A, T	Integrated water resources management to address water scarcity, flooding and disaster management. Better understanding of barriers to implementation of natural flood mitigation actions, and the use of natural water retention measures that develop, embed and assess catchment-based approaches. Medium term 10-20 years	N

Sustainable management of water resources – water quality To support the critical role clean, fresh water plays in supporting healthy communities, knowledge is required to further develop mapping, measurement and mitigation of known and emerging pollutants in our marine, freshwater and groundwater ecosystems.	A, T	Measures that develop, embed and assess the catchment-based approach in the context of National Water, Climate and Biodiversity Action Plans. Medium term 10-20 years	N
Knowledge and evidence to support soil monitoring for nature, ecosystems and biodiversity With the critical importance of soil to nature and agri-food systems being recognised through the EU Soil Strategy, there is a need for mapping, measuring and mitigating known and emerging pollutants and other pressures on our soil, across the range of soil types in Ireland.	A, T	Improved understanding of reference conditions over the range of soil types in Ireland, including those which are not productive from an agricultural perspective, and development of sustainable soil management practices that can support the health of these soils. This will include understanding, monitoring and managing atmospheric deposition of pollutants. Short term <10 years	N
Supporting the transition to sustainable land-use planning and management Land is a finite resource that is under demand for a variety of purposes and how we use our land has implications for human life, biodiversity and climate action. At EU level and nationally, the AFOLU sector has been identified as part of the solution to address urgent climate mitigation efforts and biodiversity loss. *Land-use Observatory: monitor lands, land-use, compile detailed spatial data to be used in policy implementation and integrate into planning decision-making	A, T	Improved land-use planning and management, including the development of indicators for soil monitoring, food system impacts, land-use measures and actions, and urbanisation, amongst others. Consideration should also be given to socio-economic and cultural dimensions of transition in land use to ensure a fair and sustainable distribution of effort. Short term <10 years	N

Implementing Effective Protect and Restore Solutions Wider and more rapid implementation of solutions will be essential to address climate change, changes to water quality and quantity, biodiversity loss, and nature restoration, but there is limited knowledge on monitoring and scaling-up such solutions. *Improved and accessible spatial data on biodiversity which is a need for all stakeholders and particularly for implementation of Nature Restoration Law and Plans. Data should include information on farming types, typologies, etc.	A	Improved knowledge to develop, deploy and assess protect and restore solutions for multiple benefits is required, particularly in the context of national Water, Climate and Biodiversity Action Plans. Short term <10 years	N
Understanding the Environmental Impacts of Plans With a wide range of national and international plans and policies published to inform action by government, the impacts of these plans, not only on the systems and sectors for which they have been developed, but the potentially unintended cross-sectoral impacts may be poorly understood.	S, T	Improved environmental assessment of plans and policies, including increasing public engagement, identifying and communicating the value (including financial) added by environmental assessments. Good governance strategies for the implementation of these plans and policies that enabled the production of plans whose outcomes can be identified and measured, providing the evidence base to close the policy implementation gap. Short term <10 years	N

Developing climate neutral pathways for Ireland Achieving climate neutrality by mid-century requires a comprehensive and strategic approach that aligns with national, EU and international climate objectives and contributes to the broader goal of limiting global temperature rise to well below 2 degrees Celsius.	S, T	Climate-neutral pathways will be developed for Ireland, that address gaps such as mitigation options explored to date not achieving net zero. Knowledge gaps, especially in the Agriculture, Forestry and Land-Use (AFOLU) sector, make this more challenging. Advancement of the development of integrated and cross-sectoral net-zero pathways for Ireland. Short term <10 years	N
Understanding vulnerabilities and identifying risks to inform decision-making at local level There is an adaptation deficit in Ireland with a need to comprehensively understand the vulnerabilities and risks to the impacts of climate change so that decision-makers can prioritise mitigation and adaptation strategies.	A, T	Climate event attribution will allow for improved understanding of the influence climate change is already having on weather events in Ireland and internationally. Actionable insights and practical solutions will be developed to ensure and enhance 'just resilience', reduced vulnerabilities and improved decision-making processes at the local level in the face of various climate risks and uncertainties. Short term <10 years	N
Social science, citizen science and behavioural science for climate action	A, T	Improved understanding, promotion and acceptance and influence of human behaviour in the context of climate change mitigation and adaptation efforts. Short term <10 years	N

Deep decarbonisation in agriculture and land use The land-use sector can act as both a sink and a source for greenhouse gas emissions, and thus it is imperative that we fully understand the complex links between land-use and climate.	S, A, T	Sustainable food production while increasing the AFOLU sector's carbon dioxide removal capacity. This will require a better understanding of the multidimensional land-climate-biodiversity-food-health nexus. Improved understanding of this nexus and the feasibility and impacts of the agricultural sector adopting sustainable farming practices, increasing the potential for sequestration of carbon in soils and other 'carbon farming' practices. Short term <10 years	N
Improving cross-sectoral governance in climate adaptation Climate change in Ireland impacts all aspects of society and climate-related challenges, such as increased flooding, coastal destruction, land-use change, urban pressures and agricultural impacts require multi-sectoral planning and response. To achieve this more effectively it is crucial to have a an effective and responsive cross-sectoral governance strategy to manage the move towards a climate-resilient Ireland.	S, A, T	Better understanding of the barriers to adaptation across sectors and opportunities that might arise from it. Adaptation 'storylines' to convey how adaptation can work across sectors in Ireland. * Clear protocols for decision making around adaptation around under certainty; ensuring that investments are resilient to uncertainty; good practices in place for adaptation Medium term >10 years	N
Understanding impacts of climate change on water and coastal environments and ecosystems Ireland's extensive coastline makes it vulnerable to climate change threats such as rising sea levels, increased frequency of extreme weather events and shifts in ocean currents and temperatures.	S, A	Seasonal hydrological forecasting, sea-level rise projections and understanding the impact on marine food webs, in order to mitigate the worst impacts of climate change on these environments. Short term <10 years	N

These changes can lead to coastal erosion, flooding and habitat loss, which in turn can affect biodiversity, aquaculture and tourism. Furthermore, alterations in freshwater availability and quality can impact agriculture, drinking water supplies and overall public health.			
Understanding the impacts of climate change on agriculture, forestry and land-use sectors The importance of agriculture and the land-use sector in Ireland's economy and society cannot be overestimated. Climate change poses significant risks to this sector, including altered weather patterns, water availability and frequency and intensity of extreme weather events. Land-use practices are integral to maintaining soil health, water quality, and ecosystem diversity, all of which are susceptible to climate-induced changes.	S, T	Updated climate impact assessments for the AFOLU sectors in Ireland, to develop new projections to understand pressures, improve land-use decision making and increase understanding of land-use interactions. Short term <10 years	N
Environmental Transmission of AMR & Targeted Interventions Despite progress in recent years in our understanding of the role of the environment in the transmission of antimicrobial resistance (AMR), highlighting the significant threats that exist, for example, in the aquatic environment, further research is needed to continue to identify and prioritise risks and solutions.	A, T	Better understanding of the environmental routes of transmission, persistence and dissemination of AMR, the role of environmental pressures, and impacts on human and animal health. The development of harmonised monitoring approaches and targeted and effective interventions. Short term <10 years	N

*** Relocation and realignment** As the effects of climate change are felt, there will be areas, including people's homes and livelihoods, as well as those that represent cultural and natural heritage, that cannot be saved. Understanding impacts, engagement with affected communities, and exploration of alternative and equitable opportunities will be critical during such changes.	S	Improved knowledge of the impacts of climate change, including physical, economic, socio-cultural and community impacts. Strategies to address the impacts for communities, and for relocation and realignment. Medium/longer term >10 years	N, E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

8.1.4 Sustainable urbanisation

As mentioned in the introduction, the priorities outlined here are closely based on those in the EPA Research Priorities 2024-2026, identified through a significant consultation process. The priorities and impacts reflect those within or related to the remit of the EPA and are focused primarily on addressing evidence and knowledge gaps to inform future policy, so do not represent all R&I priorities in Ireland. Those indicated with an asterisk have been added following NKS interviews.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Disentangling Sources of Air Pollution & Exploring Integrated Solutions In order to meet and go beyond the World Health Organisation's Air Quality Guidelines, research is needed to further investigate known and emerging sources of air pollution in Ireland such as backyard burning, aviation, shipping, agriculture/ammonia, black carbon, ultra-fine pollutants, indoor air pollutants, electric vehicles/hybrids	*S, A*	New solutions and action, from meaningful engagement and co-design to influence behavioural change, and to explore the co-benefits of solutions. Long term <20 years	N

as well as exploring opportunities and challenges to gathering long-term data using low-cost sensors.			
Further Understanding the Health Impacts of a Changing Environment Changes to our air, water, soil and biota resulting from climate change, extreme weather events, and increased exposure to environmental pollution (for example, noise, hazardous chemicals, microplastics, artificial light, infectious disease, radon and radiation) will have impacts on our health that could be debilitating and life threatening. Exposure and vulnerability to environmental health hazards are not equal across society with regional differences (urban/rural) and wide social vulnerabilities across Europe.	S, T	Linking of environmental and health data at a national level, including the development of an Environmental Health Atlas for Ireland and the European Human Exposome Network. Short term <10 years	N
Exploring the Health Impacts of Poor Water Quality Poor water quality can have serious impacts on human and animal health and healthcare systems whether it arises from agriculture, industry, wastewater treatment, natural sources or other reasons. Making direct connections between environmental and health data is necessary to identify potential solutions but can be difficult and requires co-operation across multiple disciplines.	S, A	Further understanding of the health impacts of poor water quality on human and animal health, and the spread of waterborne diseases to inform the development of solutions. Short term <10 years	N
Understanding the impacts of climate change on the built environment, critical infrastructure, heritage and rural communities	A, T	Land-use scenarios for urban development, stress testing critical infrastructure, and assessing vulnerabilities of tangible and intangible assets for different climatic events using a risk-based approach.	N

Climate change, increased frequency of extreme weather events and sea-level rise is exposing our built environment, critical infrastructure, cultural heritage, and rural communities to new risks.		Short term <10 years	
Migration and impacts of changing demographics Trends in housing are changing rapidly due to urban development, industrial investment, skilled-worker emigration, and the need for addition immigration to maintain economic activities. There are also trends of communities moving into rural areas with long commuting distances, urban and peri urban areas. There is a need to understand the drivers of these changes, how to ensure quality of urban spaces, need for green spaces, etc. Also impact of an aging population on urban spaces.	S, T	Improved understanding of drivers of change in urban spaces and strategies for sustainable development of spaces to meet needs of changing population. Medium/Long term >10 years	N
Value of green spaces for health and wellbeing, rewilding Impact of green spaces and rewilding on health of people, social values of nature in urban areas. Need evidence for social return on investment. Research priority should be focused in exploring its effects in comparison to an engineered solution.	S, T	Accepted methodologies for valuing of green spaces, nature, etc in urban environments to inform decision making/planning. Short term <10 years	N, E
Appraisal methodologies for transport decisions Need to reconsider how we evaluate transport and not make decisions on what is the quickest or best benefit-cost ratio.	A, T	More holistic approach to decision-making in transport that incorporates more than just considerations of cost or carbon reductions. Short term <10 years	N, E

Need also to consider ancillary benefits of decarbonising transport – not just carbon – need also to quantify other benefits to public such as health, air quality, etc.			
Focus on hard-to-reduce emissions in transport in Ireland, including **Sustainable freight in urban areas**: Need to gain an improved understanding of how freight is transported in urban environments and better data in order to develop strategies to decarbonise this. **Access to transport in rural communities**	A, T		N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

8.1.5. Nature & environmentally friendly energy transition

As mentioned in the introduction, the priorities outlined here are closely based on those in the EPA Research Priorities 2024-2026, identified through a significant consultation process. The priorities and impacts reflect those within or related to the remit of the EPA and are focused primarily on addressing evidence and knowledge gaps to inform future policy, so do not represent all R&I priorities in Ireland. The energy transition is not directly within the EPA's remit, so the list below reflects those areas of interest to the EPA.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Climate Action: Bringing Mitigation and Adaptation Together Mitigation efforts aimed at reducing greenhouse gas emissions are crucial for minimising the severity of climate impacts. However, certain climate impacts are already 'locked in' due to our past emissions and adaptation	S, A, T	Strategies to identify synergies, minimise trade-offs and optimise resource allocation, leading to more cost-effective and holistic approaches to climate action in Ireland. Medium term 10-20 years	N, E, I

measures are equally critical for building resilience and minimising vulnerability to climate-related risks in Ireland. An integrated approach to mitigation and adaptation strategies can help mainstream climate considerations into broader policy agendas, foster interdisciplinary collaboration and enhance Ireland's capacity to effectively respond to the complex and interconnected challenges posed by climate change.			
Developing climate neutral pathways for Ireland Achieving climate neutrality by mid-century requires a comprehensive and strategic approach that aligns with national, EU and international climate objectives and contributes to the broader goal of limiting global temperature rise to well below 2 degrees Celsius.	S, T	Climate-neutral pathways will be developed for Ireland, that address gaps such as mitigation options explored to date not achieving net zero. Knowledge gaps, especially in the Agriculture, Forestry and Land-Use (AFOLU) sector, make this more challenging. Advancement of the development of integrated and cross-sectoral net-zero pathways for Ireland. Short term <10 years	

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

8.1.6 Other themes / crosscutting themes

As mentioned in the introduction, the priorities outlined here are closely based on those in the EPA Research Priorities 2024-2026, identified through a significant consultation process. The impacts are focused primarily on addressing evidence and knowledge gaps to inform future policy. Those indicated with an asterisk have been added following NKS interviews.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Environmental and social inequalities There exist significant inequities in respect to exposure to environmental risks, with vulnerable groups or communities with lower levels of income or education being exposed to higher levels of noise and air pollution and with reduced access to green and blue spaces, with associated impacts on health and wellbeing.	S	Better understanding of social determinants of inequalities in environmental risk; policies and practices that promote environmental justice; financial mechanisms and business models to ensure a just and sustainable transition. Medium term (10 years)	N
Data & digitalisation solutions to support the protection and restoration of the environment The rapid development of digital technologies and growth of data represent new opportunities and challenges for environmental protection. An integrated approach is needed to harness the potential of digital and data technologies to support environmental policy, while ensuring transparency, authenticity, interoperability and public accessibility of the data and information.	S	Novel tools, technologies and digital solutions to address environmental issues, such as those that fully exploit earth observation data, geospatial data, socio-economic data sources, artificial intelligence and emerging technologies; integrated, cross-sectoral data management systems. Medium term (10 years)	N

Societal transformation to support the protection and restoration of the environment The European Green Deal is an ambitious plan to transform the EU into a modern, resource-efficient and competitive economy that ensures no net emissions of greenhouse gases by 2050, economic growth is decoupled from resource use and no person and no place is left behind. To enable this transition, we will need to engage individuals and communities, drive behavioural change, and achieve systems-level change across all sectors.	S	Strategies to promote inclusive and active community engagement and empowerment; behavioural change to support the transition to sustainability; and economic opportunities and trade-offs that can arise from policies focused on innovation, sustainable practices and clean technologies. Medium term (10 years)	N
Social and geopolitical risks to the environment Ireland has set out an ambitious and necessary objective to transition to a competitive, low carbon, climate-resilient and environmentally sustainable economy by 2050. National roadmaps and action plans outline the decisive action required to navigate this transition, but there remain risks, geopolitical, economic and otherwise, that fall outside the remit of these plans that could impact their success.	S	Improved understanding and strategies to address denial of science and misinformation relating to environmental issues; knowledge of the risks posed by geopolitical instability and impacts on supply chains; methods for conducting horizon scanning and considering futures scenarios; and to build resilience to mitigate these risks. Short/medium term (10 years)	N/E

Policy Implementation, Effective Regulation, and Innovative Governance Models Effective implementation of policy and regulation, across all sectors and at all levels from national to local, is critical to Ireland achieving our climate and environmental targets. This requires new integrated approaches to ensure policy coherence; appropriate governance structures; and effective regulation and enforcement.	S	International benchmarking, learnings on national and local enforcement strategies, and ex-post analysis of current policies to assess how well they deliver on their environmental objectives, particularly in areas such as industrial emissions, waste management, and drinking and waste water treatment. New and agile governance models that incorporate systems and socio-ecological considerations in complex, multi-stakeholder, multi-sectoral policy areas; and the development of indicators to measure progress in implementation. Short/medium term (10 years)	N/E
Alternative economic paradigms for sustainability In moving toward a competitive, low carbon, climate-resilient and environmentally sustainable future, consideration should be given to alternative economic paradigms that could enable or accelerate this transition.	S	Understanding of the feasibility and impacts of alternative economic paradigms in Ireland, including a 'post-growth' system and how economic growth could be 'decoupled' from climate, waste, pollution and biodiversity impacts. Long term (>20 years)	N
Planning for changing demographics Longer term consideration of effects of a growing population in Ireland, as well as aging, immigration, emigration, urbanisation, etc. Across all areas, an improved understanding of how changing demographics in Ireland can be incorporated into policies, plans, strategies and solutions to ensure they are appropriately futureproofed, in so far as is possible.			

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

8.2 Promising funding schemes

The main points raised during the interviews with the NKS with regard to research funding include the following:

Collaborative funding approaches

- The most effective funding schemes are those that foster collaboration among diverse stakeholders, enabling a more comprehensive approach to addressing specific research needs.
- Collaboration between funding agencies in joint initiatives have been successful in bridging gaps between the scopes of different agencies, fostering more comprehensive and impactful research.

Balance of blue-skies research and applied research

- Blue skies research encourages exploration of innovative, novel and untested ideas that can lay the groundwork for future, more targeted studies. An imbalance between blue-skies and applied, thematic research may limit potential for breakthrough discoveries in underfunded thematic areas.

Supports for inter- and trans-disciplinary research

- Current funding schemes do not sufficiently address and support interdisciplinary research, particularly projects that could deeply engage natural and social sciences. Addressing this would support more holistic research approaches.
- Fora, such as citizen assemblies, could play a role in driving research in areas of public concerns as well as highlighting emerging research priorities.

Bringing together researchers, as well as other experts

- Tactical research groups that focus on specific, high-priority areas can produce more definitive and actionable results, contributing to a shared understanding and rapid application of research findings
- Creating specialized research groups around specific topics allows experts to collaboratively discuss and refine research questions, leading to more effective funding calls and improved research outcomes.
- Groups of specialists forming micro-ecosystems within research areas can lead to better collaboration, more targeted research efforts

Additional and sustained funding

- In Ireland, the proportion of GDP allocated to R&I is smaller compared to many other countries, which means that some thematic areas have not received sufficient funding
- Sustained investments in research is required to address longer-term priorities

8.3 Improving the Science Practice Policy interface (SPPI)

The knowledge transfer landscape is evolving quickly and growing in importance both nationally and internationally. The national R&I strategy Impact 2030 places a strong focus on building stronger connections between the R&I and policymaking systems and improving the accessibility and uptake of publicly funded research by policymakers. Similarly, one of five goals in the Department of the Environment, Climate and Communications (DECC's) new R&I Strategy is focused on knowledge transfer, including developing people and skills within the department with the aim of improving the use of research outputs in policy development and delivery i.e. improving the demand side, which is just as important as improving the supply side.

The EPA Research Programme has a strong track record in engaging with relevant stakeholders throughout the research project cycle, from the initial pre-award steps of identifying knowledge gaps to inform research calls and evaluating high quality, impactful research projects, through to facilitating active participation by relevant stakeholders in project Steering Committees, and finally the dissemination of research outputs at project completion. It is currently focusing efforts on proactively engaging in knowledge transfer activities post project completion with the aim of promoting the uptake of research outputs by policymakers.

The main points raised during the interviews with the NKS include the following:

Accessibility of outputs from all research projects

- Important for outputs from all research projects to be accessible so that they can be used to inform policy.
- All research projects should be required to produce a policy brief that outlines how the project is or could be relevant to policy.

Early engagement is crucial

- Researchers are often asked for input to policy development and implementation at a very late stage. Earlier engagement would make inputs more informed and impactful.

Improved opportunities for engagement

- Researchers often do not get any or regular opportunities to engage with policy makers. Conferences, events or fora should be considered to facilitate more engagement between researchers and policy makers in relevant areas.
- Need to foster more two-way communication and ensure ongoing dialogue. For example, following-up with a researcher if their research has been employed in policy development or implementation.
- Consider more placement opportunities for postgraduate students.

Capacity building

- Awareness needs to be raised with both researchers and policy makers on potential for engagement, how to do this, and how the respective systems operate. For example, policy makers cannot expect that researchers are available or have resources at short notice to provide advice/evidence.

Supports for communications and dissemination activities

- Sufficient funding must be made available for planning, preparation and delivery of effective communication and dissemination of the outputs from research projects, including for the purposes of informing policy.
-

8.4 Recommendations for CASRI by NKS

The NKS interviews did not concentrate on additional recommendations for CASRI, given the other information provided as recommendations for priorities/funding/SPI. Most comments given were to feedback that the NKS thought it was positive to see the agencies across the EU working collaboratively.

8.5 Reflection on the workflow

As set out in the introduction, the priorities outlined in this National Review are closely based on those in the EPA Research Priorities 2024-2026, identified through a significant consultation process. The impacts are focused primarily on addressing evidence and knowledge gaps to inform future policy, rather than addressing broader technology needs, for example.

While the process and timeline used by the EPA process for identifying priorities aligns strongly with the CASRI process, there are certain differences and limitations. The EPA conducted an in-depth desk-based review and engaged with over 260 stakeholders in identifying its priorities, but this review and the stakeholders were limited to those relevant to the remit of the EPA. Conversely, the CASRI process engaged fewer stakeholders but across a broader range of societal challenges. This should be taken into consideration in the interpretation of the results presented here.

The identification of research priorities is essential to ensure that funding is directed appropriately and effectively, so approaches such as that used in CASRI should be encouraged. If the EPA were to be involved in similar transnational projects to explore research priorities, we would consider whether a narrower selection of thematic areas might allow for a more focused selection and engagement with stakeholders, and more in-depth exploration of priorities and potential impacts.

A slightly different approach for collecting information was chosen based on significant work already undertaken as described above. As such it was chosen not to hold a separate workshop on top of the interviews.

9 ITALY – National Report

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SUMMARY IN ITALIAN

SINTESI

Introduzione

In Italia, la ricerca e innovazione ambientale e di sostenibilità (ES R&I) hanno come riferimento una combinazione di politiche nazionali, regionali ed europee. Il paese possiede una forte tradizione di ricerca scientifica e tecnologica, supportata da un solido sistema di università e istituti di ricerca. Accanto alle istituzioni di ricerca pubblica operano enti di ricerca pubblico-privati e privati ed università non statali. Il sistema nella sua interezza partecipa alle principali reti, programmi e infrastrutture di ricerca europei e internazionali. Le priorità della ricerca pubblica sono definite nel Programma nazionale per la ricerca che è corredato da un Programma Nazionale per la Scienza Aperta e da Piano Nazionale infrastrutture di ricerca. La spesa per R&S in rapporto al PIL pur cresciuta è costantemente al di sotto della media UE anche se negli ultimi anni il sistema nazionale della ricerca è stato chiamato a utilizzare ingenti risorse derivanti dal PNRR (Piano Nazionale di Ripresa e Resilienza) con cui sono stati finanziati un gran numero di dottorati di ricerca e diverse tipologie di progetti che hanno aggregato gli attori della ricerca e in alcuni casi anche con la partecipazione delle imprese su alcune priorità strategiche e per la costruzione di infrastrutture di ricerca.

In linea generale, tuttavia, la discontinuità dei finanziamenti, sia per il personale che per i progetti, e il peso di oneri burocratico-amministrativi che riducono il tempo utile per la ricerca, limita fortemente le potenzialità del sistema della ricerca italiana determinando, fra l'altro, una scarsa capacità attrattiva, per l'incertezza sulle possibilità di carriera e di ricerca, che ha condotto ad una forte emigrazione dei laureati e dei dottorati formati dalle università italiane non compensato da un pari flusso in entrata.

La possibilità per i ricercatori di operare in un contesto che favorisca il dialogo e la collaborazione fra i diversi ambiti di ricerca, fra le competenze STEM (Science Technology Engineering Mathematics) e quelle umanistiche e giuridico-sociali, ma anche con la società civile, il mondo produttivo e i decisori politici e garantisca un coordinamento negli strumenti di finanziamento potrebbe fortemente aumentare la capacità di realizzare ricerca scientifica e di prevederne un alto impatto in termini sociali ed economici.

In particolare, si rileva una difficoltà del vasto tessuto delle PMI, che costituisce un elemento peculiare del mondo produttivo dell'Italia nel contesto europeo, ad accedere direttamente ai progetti di ricerca e sviluppo o ad utilizzare i risultati della ricerca con la conseguenza di rallentare la loro transizione ecologica, energetica, digitale e tecnologica.

SRIA

L'Italia ha adottato diverse strategie e piani d'azione per promuovere la sostenibilità e affrontare le sfide ambientali. Tra questi, il Programma Nazionale per la Ricerca, (PNR), il Piano Nazionale Integrato per l'Energia e il Clima (PNIEC), la Strategia Nazionale per l'Economia Circolare e la Strategia Nazionale per lo Sviluppo Sostenibile (SNSvS) sono documenti chiave che guidano le politiche e le iniziative di ricerca.

Schemi di Finanziamento

L'Italia beneficia di una varietà di programmi di finanziamento a livello nazionale ed europeo. Tra questi, Horizon Europe, il Fondo Europeo per lo Sviluppo Regionale (FESR), il Piano Nazionale di Ripresa e Resilienza (PNRR) e il Fondo per l'Innovazione sono strumenti fondamentali per supportare la ricerca e l'innovazione nel campo della sostenibilità.

Garantire una continuità nel finanziamento è fondamentale per raggiungere obiettivi a lungo termine. Un supporto finanziario costante evita la frammentazione, che altrimenti potrebbe ostacolare il progresso e compromettere la sostenibilità dei progetti nel tempo. Abbiamo dei mali comuni, intesi come condizione comune che solleciti la convergenza di risorse finanziarie a livello europeo (perdita di biodiversità, cambiamento climatico etc.…) ed è in questi campi che devono convergere le ricerche. Un altro aspetto cruciale riguarda la semplificazione dei processi. La burocrazia e la complessità amministrativa rappresentano infatti barriere significative sia per l'accesso ai finanziamenti sia per l'implementazione dei progetti. Rendere i processi più snelli e accessibili è quindi essenziale per favorire una partecipazione ampia ed efficace ai programmi di finanziamento. Infine, è necessario ripensare i modelli di business esistenti, poiché gli strumenti attualmente disponibili per le piccole e medie imprese (PMI) non risultano sempre adatti alle caratteristiche specifiche dell'imprenditoria italiana. È dunque importante sviluppare strumenti di supporto che siano meglio allineati alle esigenze delle PMI, così da facilitare il loro sviluppo e il loro successo.

SPPI

È necessario un maggiore coordinamento tra le politiche e le strategie a livello nazionale e regionale per garantire coerenza ed evitare inefficienze. La frammentazione delle politiche può infatti portare a duplicazioni di sforzi e limitare l'efficacia complessiva delle iniziative. Un altro punto fondamentale è il coinvolgimento degli stakeholder. Per garantire che le soluzioni sviluppate siano concretamente applicabili, è cruciale che le comunità locali, le imprese e altri attori partecipino attivamente ai processi decisionali e alle attività di ricerca. Questo assicura che le strategie proposte siano radicate nella realtà e rispondano alle esigenze specifiche dei territori. Inoltre, migliorare la raccolta, la gestione e la condivisione dei dati tra le varie istituzioni e organizzazioni è essenziale per favorire decisioni basate su evidenze solide. Un sistema integrato di dati consente di avere una visione più completa e informata, potenziando l'efficacia delle strategie messe in campo. Un altro aspetto critico è l'applicazione pratica della ricerca. Spesso, i risultati delle ricerche non vengono valorizzati a dovere e rischiano di rimanere solo a livello teorico. È importante dunque favorire la creazione di collegamenti che rendano i risultati della ricerca attraenti e realmente utili per il contesto locale. Per sostenere l'innovazione e garantire la sostenibilità nel lungo termine, è indispensabile investire nelle competenze e nelle capacità dei giovani. La formazione pratica e l'aggiornamento continuo delle competenze sono elementi chiave per costruire un futuro solido e competitivo. Infine, una comunicazione scientifica efficace è fondamentale per aumentare la consapevolezza e il supporto pubblico verso le iniziative di sostenibilità. Rendere accessibili le conoscenze scientifiche e coinvolgere cittadini e stakeholder permette di costruire un consenso diffuso e di promuovere l'impegno collettivo verso una maggiore sostenibilità. Per garantire una maggiore tutela dei beni comuni e rispondere efficacemente alle sfide ambientali, si può istituire un'autorità competente per la protezione dei beni comuni che agirebbe come garante. Si propone anche di eliminare le barriere

economiche che limitano la tutela ambientale attraverso l'accesso gratuito alla giustizia per le controversie ambientali, escludendo l'attribuzione delle spese processuali.

Questa misura agevolerebbe i cittadini e le organizzazioni nella difesa dell'ambiente, permettendo una partecipazione attiva senza il timore di oneri finanziari. Infine, l'attivazione di una azione popolare in ambito ambientale, ovvero l'attribuzione dell'interesse pubblico ai problemi ambientali, piuttosto che a un territorio specifico, permetterebbe ai cittadini di intervenire per la tutela ambientale anche al di fuori dei propri confini geografici. Questo strumento consentirebbe una partecipazione più ampia e un'azione collettiva sui temi ambientali, basata sull'interesse per la salute dell'ecosistema globale piuttosto che su limitazioni locali.

Conclusione

L'Italia ha un forte potenziale per progredire nella ricerca e innovazione ambientale e di sostenibilità, grazie a un solido sistema di ricerca e politiche di supporto. Tuttavia, affrontare queste sfide richiede un approccio integrato e collaborativo, coinvolgendo tutti gli attori chiave e promuovendo soluzioni innovative e sostenibili, favorendo una maggiore integrazione e collaborazione tra le parti coinvolte.

EXECUTIVE SUMMARY

In Italy, environmental sustainability research and innovation (ES R&I) are guided by a combination of national, regional, and European policies. The country boasts a strong tradition in scientific and technological research, supported by a robust system of universities and research institutes, including public, private-public, and private entities as well as non-state universities. This entire system participates in leading European and international research networks, programs, and infrastructures. Public research priorities are defined in the National Research Program, which is supported by the National Open Science Program and the National Research Infrastructure Plan. Although R&D spending as a percentage of GDP has increased, it remains below the EU average. Recently, however, the national research system has received significant resources from the National Recovery and Resilience Plan (PNRR), which has funded numerous PhD programs and projects, promoting collaboration among research stakeholders and, in some cases, with businesses on strategic priorities and research infrastructure development.

Nevertheless, the inconsistency of funding for both personnel and projects, coupled with administrative burdens that reduce time available for research, significantly limits the potential of the Italian research system. This limitation affects its attractiveness due to uncertainty in career and research opportunities, resulting in a high rate of emigration among graduates and PhD holders trained in Italian universities, without an equal incoming flow.

Creating a supportive environment that fosters dialogue and collaboration among research fields, including STEM (Science, Technology, Engineering, Mathematics), humanities, social sciences, civil society, the productive sector, and policymakers, alongside streamlined funding coordination, could greatly enhance the capacity to conduct impactful scientific research with social and economic benefits.

Additionally, the extensive network of small and medium-sized enterprises (SMEs), a distinctive aspect of Italy's productive sector within Europe, faces challenges in accessing R&D projects or

utilizing research outcomes, thus slowing down their green, energy, digital, and technological transitions.

SRIA

Italy has implemented various strategies and action plans to promote sustainability and address environmental challenges. Key documents guiding these policies and initiatives include the National Research Program (PNR), the National Integrated Plan for Energy and Climate (PNIEC), the National Strategy for Circular Economy and the National Strategy for Sustainable Development (SNSvS).

Funding Schemes

Italy benefits from a variety of funding programs at the national and European levels. Horizon Europe, the European Regional Development Fund (ERDF), the National Recovery and Resilience Plan (PNRR), and the Innovation Fund are essential instruments for supporting sustainability-related research and innovation.

Ensuring funding continuity is crucial for achieving long-term objectives. Consistent financial support helps prevent fragmentation that could otherwise hinder progress and compromise project sustainability over time. Some challenges, like biodiversity loss and climate change, demand a convergence of European financial resources to tackle these shared concerns. Simplifying processes is also critical, as bureaucracy and administrative complexity pose significant barriers to accessing funding and implementing projects. Streamlined, accessible processes are therefore essential to encourage broad and effective participation in funding programs. Finally, rethinking current business models is necessary, as existing tools for SMEs may not fully align with the specific characteristics of Italian entrepreneurship. Developing better-suited support tools for SMEs is crucial for their growth and success.

SPPI

Greater coordination between national and regional policies and strategies is needed to ensure consistency and avoid inefficiencies. Fragmented policies can lead to duplicated efforts and reduce the overall effectiveness of initiatives. Another key point is stakeholder engagement. Active participation from local communities, businesses, and other actors in decision-making processes and research activities ensures that proposed strategies are grounded in reality and meet specific local needs. Improving data collection, management, and sharing among institutions and organizations is essential for supporting evidence-based decisions. An integrated data system allows for a more comprehensive and informed approach, enhancing the effectiveness of implemented strategies.

Another critical aspect is the practical application of research. Often, research results remain underused and risk remaining theoretical. Building connections that make research outcomes attractive and genuinely useful for local contexts is vital. To support innovation and ensure long-term sustainability, investing in young people’s skills and abilities is crucial. Practical training and continuous skills updates are key to building a solid and competitive future workforce. Finally, effective scientific communication is fundamental for raising awareness and public support for sustainability initiatives. Making scientific knowledge accessible and involving citizens and

stakeholders helps build broad consensus and promotes collective commitment to sustainability. To ensure greater protection of common goods and respond effectively to environmental challenges, a competent authority for the protection of common goods could be established to act as a guarantor.

It is also proposed to remove economic barriers that limit environmental protection by offering free access to justice for environmental disputes, excluding the allocation of legal costs. This measure would facilitate citizens and organizations in defending the environment, allowing active participation without the fear of financial burdens. Lastly, the activation of a popular action in the environmental field—assigning public interest to environmental issues rather than to a specific territory—would enable citizens to intervene for environmental protection even beyond their own geographical boundaries. This tool would allow broader participation and collective action on environmental issues, based on an interest in the health of the global ecosystem rather than local limitations.

Conclusion

Italy has strong potential to advance in environmental sustainability research and innovation, supported by a robust research system and supportive policies. Addressing these challenges requires an integrated, collaborative approach, engaging all key stakeholders and promoting innovative and sustainable solutions, while encouraging greater integration and collaboration among involved parties.

9.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

9.1.1 National research context

National Sustainability Goals in the Current R&I Agenda

The primary sustainability goals in Italy's current Research and Innovation (R&I) agenda focus on climate action, circular economy development, renewable energy expansion, and sustainable resource management. Additionally, there is a strong emphasis on biodiversity preservation, sustainable agriculture, and urban resilience to adapt to climate-related risks. The aim is to drive long-term economic, social, and environmental benefits, aligning closely with the European Green Deal and the United Nations Sustainable Development Goals (SDGs).

Policies Guiding R&I Towards Sustainability Goals

To guide R&I efforts toward these sustainability objectives, Italy has introduced several policies and strategies at both national and regional levels. Key among these is the National Research Program (PNR), which sets research priorities in line with sustainable development, and the National Integrated Energy and Climate Plan (PNIEC), which outlines energy efficiency and carbon neutrality targets. The National Strategy for Sustainable Development (SNSvS) also plays a critical role, integrating sustainability considerations across all R&I projects and ensuring alignment with broader European initiatives. The National Recovery and Resilience Plan (PNRR) provides significant funding to support R&I initiatives in these areas, promoting digital transformation, green innovation, and inclusive growth.

Current R&I Infrastructure: Strengths and Weaknesses

Italy's R&I infrastructure is well-established, supported by a network of universities, research institutes, and public-private partnerships that foster innovation and development in key areas of

sustainability. A notable strength is the country's robust academic foundation, with universities contributing significantly to technological advancement and scientific discovery. Additionally, various national agencies support research in sustainability and environmental protection, including through grants and technical assistance. However, challenges persist, such as fragmented expertise across institutions and bureaucratic complexities that can slow down project implementation and limit cross-sector collaboration. Further efforts are needed to streamline administrative processes and enhance the integration of sustainability-focused research initiatives across institutions.

The Role of Italy's Environmental Protection Agency (ISPRA)

ISPRA uniquely fulfils a dual role as both Italy's national environmental protection agency and a dedicated research institute. This dual mandate enables ISPRA to play a pivotal role in advancing environmental research and innovation (R&I) while also enforcing environmental protection standards. As an environmental agency, ISPRA provides regulatory oversight and monitoring, ensuring that national R&I initiatives align with sustainability goals and legal frameworks. Concurrently, as a research institution, ISPRA conducts studies and technical assessments that inform and support evidence-based policy decisions. By linking regulatory responsibilities with active research, ISPRA effectively bridges the gap between scientific discovery and policy implementation, supporting the development of practical, innovative solutions that address Italy's unique environmental challenges. This integrative approach allows ISPRA to serve as both a guide and a contributor within Italy's sustainability-focused R&I landscape.

9.1.2 Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Product design - extend the product's lifespan and facilitate the recycling or reuse of components	T, S	Supports the circularity paradigm (>20 years)	I, E
Governance solutions (managing innovation) - optimize decision-making processes	S	Reduces the time and costs associated with implementing new ideas. Facilitates collaboration between different organizational units, promoting a more integrated and cohesive work environment (>20 years)	E, N
Taking into reality the outputs of the different projects	A	Enhanced Project Success (>20 years)	N, R
Complete Mapping and National planning	T, S	Leads to clearer strategy and better alignment of goals and actions. Better coordination of resources and efforts across various sectors, ensuring that development goals are met more efficiently (>20 years)	I, E, N
Finding tools to foreseen uses and needs of critical raw materials	S, T	Reduces supply risks and ensures long-term availability (>20 years)	I
Research on the removal of micro-pollutants	T, S	Essential both for the production of drinking water and for the reuse of wastewater (< 10 years)	N
Efficient management of water resources	A	Water saving through the adoption of appropriate agronomic practices and controlled irrigation techniques and precise fertigation (>20 years)	R, N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

9.1.3 Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
DSS - Decision Support System	S	Integrates all the components of sustainable development into a single management system based on scientific principles (> 20 years)	I, N
Remote sensing and Earth Observation, sensors, AI	A	Aids in tracking changes in biodiversity, identifying threatened areas, and implementing effective conservation strategies (> 20 years)	I, E
Research on the assessment of mitigation and adaptation related to species' responses to climate change	S	Enhances our resilience to the effects of climate change strategies (> 20 years)	I, E
Making data capitalization operational	A	Data available for model replication (< 10 years)	R, N, E
Institutional reference point for research on biodiversity to ensure sustainability	A	Reduce the fragmentation of competent institutions (< 10 years)	R, N, E
Raising awareness in civil society about the issue of sustainability and the adaptation and mitigation of climate change	A,	Strengths biodiversity policies implementation (> 20 years)	R, N, E

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

9.1.4 Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Quantitative risk assessment - Finding actions that have benefits in literature but with collateral effects in practice	S, T	Promote research on methods and tools to assess and mitigate risks more accurately and informatively (> 20 years)	I, E

Sponge city	S, T	Better management of water resources. Improves urban resilience, reduces the risk of flooding, and enhances water quality (> 20 years)	E, N, R
Representation of all contexts (the Mediterranean, Eastern Europe, etc.)	S, T	A balanced approach that includes different regions and contexts helps to avoid bias and ensures that research results are applicable and useful globally (> 20 years)	I, E, R
Mobility (intermodality, mix of modalities)	T	A more sustainable, equitable, and efficient transportation system (10-20 years)	N
Intersection between climate data and urban/social aspects	S	Cities more resilient to climate change. Improves urban quality of life through sustainable resource management and emission reduction.	R, N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

9.1.5 Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Storage and integration	A, S	Reduces reliance on imported energy and enhance energy security, can reduce greenhouse gas emissions (< 10 years)	E, R
Energy (energy mix) – all renewable sources, nuclear energy, CO_2 capture and storage	S	Long-term impact on competitive productivity – local production of technologies (> 20 years)	N
Renewable energy sources and their social impact	S	Overall improvement of social, economic, and environmental sustainability (> 20 years)	N
Generation of scenarios	S	Better-prepared organizations and societies, capable of adapting to change and ensuring more sustainable, resilient outcomes (>20 years)	N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

9.1.6 Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Environmental law	T, S, A	Ensures that policies and regulations are effective and adapt to emerging challenges, with a positive impact on multiple dimensions of sustainability (> 20 years)	N
Educational policy to tackle complex challenges like sustainability and social inclusion	T, S, A	Creates a more innovative and responsible workforce and enhances community resilience, improving awareness and social action (> 20 years)	N, I
Interaction between climate change and soil – how much does soil sealing impact and vice versa	S	Better stormwater management. Mitigates the “urban heat island” effect. Reducing soil sealing allows the soil to continue its role as a carbon sink (< 10 years)	N, R
Interrelation between agro-systems, natural ecosystems, and society in a one health vision	T	Regeneration of the food system in terms of social, economic, nutritional, and environmental sustainability (< 10 years)	R, N, E, I
Genetic innovations for agriculture	S	Development of new varieties resilient to major biotic and abiotic stresses, also improved in terms of quality and nutrition (> 20 years)	R, N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

9.2 Promising funding schemes

Italy has several effective funding schemes in place, the most important are Horizon Europe, including Eu-partnerships, INTERREG, LIFE, PNRR, MASE, and FESR. These programs have been instrumental in supporting a wide range of research and innovation activities, driving significant progress in various fields.

The right model of funding depends on the topics and research targets. If the topics have implications for businesses, venture capital might be appropriate. For more general topics, such as biodiversity, European funding can work better together with private foundations.

However, there are still some thematic areas that are not sufficiently covered by existing funding. These include the social and legal impacts of climate change, innovation in the circular economy and product design. Addressing these gaps is essential for comprehensive and impactful research. There are specifics highlight critical gaps in funding that need to be addressed to develop effective strategies for sustainable urbanization and biodiversity conservation: risk assessment and management (comprehensive strategies to assess and manage multiple climate hazards in urban areas), water management solutions to handle intense precipitation and reduce urban flooding (Innovative urban water management solutions like “sponge cities” and “water squares.”); taxonomy and basic research to understand biodiversity, integration of environmental and socioeconomic data, support for decision-making Human Capital and Long-Term Research Support, promising new funding schemes that could help include Joint Research Platforms (JRP), and innovation funds specifically for SMEs. These schemes offer innovative ways to support research and ensure practical applications of scientific advancements.

To persuade national funders to join cross-national funding initiatives, we must emphasize several key points:

1. **Greater Impact and Efficiency**: Collaborative efforts lead to more significant and efficient outcomes.
2. **Leveraging Synergies**: Pooling resources and expertise avoid duplication and maximizes benefits.
3. **Access to Broader Networks and Expertise**: Cross-national initiatives provide access to a wider range of knowledge and skills.
4. **Addressing Global Challenges**: Many challenges, such as climate change, require coordinated global responses.
5. **Strengthening National Research Capabilities**: Participation enhances national research through exposure to diverse methodologies and best practices.
6. **Political and Economic Benefits**: International collaboration boosts political standing and drives economic growth through innovation.

9.3 Improving the Science Practice Policy interface (SPPI)

Interaction within SPPI needs to be planned in advance. Several key organizations play pivotal roles in facilitating this interaction: Environmental Protection Agencies (EPAs) act as intermediaries between scientific research and policy implementation. They participate in working groups and provide technical support to policymakers. For example, EPA networks facilitate dialogue and collaboration between researchers and government institutions, ensuring that scientific findings are translated into actionable policies. Universities and Research Institutes conduct both fundamental and applied research, often in collaboration with policymakers and practitioners. The first should be

granted endlessly, the second one should be granted for well-established priorities. They provide the scientific evidence and expertise necessary to inform policy decisions. Some institutions engage in projects that directly address policy needs, bridging the gap between science and practice. International Networks and Partnerships facilitate cross-border collaboration and knowledge exchange, helping to align national policies with international standards and best practices. The European Environment Information and Observation Network (EIONET) and initiatives like Horizon Europe promote international cooperation in research and policy, enhancing the global impact of scientific endeavours. Public-Private Partnerships (PPPs) bridge the gap between research, industry, and policy by fostering innovation and practical applications of scientific research. Joint Research Platforms (JRP) and initiatives like Important Projects of Common European Interest (IPCEI) support collaborative projects that drive technological advancements and policy integration, ensuring that scientific discoveries are effectively utilized in the real world. Non-Governmental Organizations (NGOs) and Foundations advocate for science-based policies and engage in public education and stakeholder engagement. They often act as mediators between the scientific community and policymakers. Organizations like the Alleanza Italiana per lo Sviluppo Sostenibile (ASviS) promote sustainable development goals and influence policy through advocacy and education, ensuring that scientific insights are incorporated into policy frameworks. The mediation of the third sector is essential for the dissemination to the public of scientific research.

Despite these efforts, several challenges are still open:

1. **Communication Gaps** between scientific community and policymaker leads to miscommunication and underuse of scientific evidence in policy decisions. Scientific findings may be too technical for policymakers to understand and apply effectively.
2. **Bureaucratic Hurdles**: Complex administrative processes and rigid funding mechanisms can hinder the timely implementation of research findings into policy. The bureaucratic burden of programs like Horizon Europe can delay project execution and reduce efficiency.
3. **Lack of Stakeholder Engagement** leads to policies that are not well-aligned with public needs and expectations. There are limited platforms for dialogue between researchers, policymakers, and the public.
4. **Fragmentation of Efforts** due to lack of coordination among various organizations and sectors leads to duplication of work.

9.4 Recommendations for CASRI by NKS

Points of Attention

Fragmentation and bureaucracy: Many funding initiatives are fragmented and come with complex bureaucratic requirements. Greater cohesion among stakeholders and simplification of processes are essential to improve access to funds, especially for SMEs and local projects.

Coordination Among Institutions: Coordination among research institutions, universities, and environmental authorities is limited. To ensure greater efficiency, it would be beneficial to improve collaboration between these actors by promoting dialogue platforms and data-sharing initiatives.

Recommendations

Promote Joint Research and Funding Platforms: Create more accessible joint research platforms and shared funding schemes to encourage collaboration among member states, regions and

international institutions. This approach would also help reduce fragmentation and increase the effectiveness of allocated funds.

Support Flexibility in Funding Allocation: Introduce more flexible funding mechanisms to allow for adaptable use of resources, especially to respond quickly to environmental emergencies. This is crucial for projects requiring long-term commitment and that must adapt to variable contexts.

Enhance Stakeholder Engagement: Create spaces for dialogue and active participation to involve citizens, NGOs, and other stakeholders. Create platforms for dialogue and collaboration. Encourage participatory approaches.

Strengthen Capacity-Building Programs: Invest in skill-building, particularly in scientific communication and knowledge brokering capabilities. This would facilitate better exchanges between science, policy, and practice, fostering the practical application of scientific discoveries and improving decision-making effectiveness.

Enhancing Communication and Knowledge Translation: translate scientific findings into actionable policy recommendations.

Streamlining Administrative Processes: Simplify bureaucratic procedures and improve accessibility to funding. Funding agencies and governmental bodies should work together to reduce administrative burdens and improve their administrative action. Strategic policies should last at least 5 years.

Promoting Integrated and Coordinated Efforts: Foster collaboration and data sharing among different organizations and sectors to ensure cohesive and comprehensive approaches to policy and practice.

9.5 Reflection on the workflow

The information accurately represents the research landscape in Italy. Saturation of responses became evident after the first few interviews. Each interview provided interesting individual insights, but the main themes and findings, especially regarding challenges and weaknesses, continued to resurface. We therefore believe that the report effectively reflects the national situation in environmental research. Initially, we presented the questionnaire in its entirety. As we progressed with the interviews, we began to focus on the three main questions, allowing our NKS to freely share their perspectives, from which we gathered elements to answer the questions.

The desk study provided a broad and structured overview of available literature, focusing on established frameworks, national and international reports, and predefined funding mechanisms. However, it lacked real-time insights into practical challenges and emerging thematic needs, which were highlighted through the interviews and workshops. The interviews added depth by capturing specific feedback on issues like bureaucracy and stakeholder engagement, reflecting first-hand accounts of obstacles faced by institutions and identifying gaps in existing funding for priority areas. The workshop allowed for real-time collaboration, bringing to light recurring themes, such as the need for coordinated funding approaches and streamlined administrative processes. It also reinforced a consensus on themes where existing funding was insufficient, and participants could share best practices and discuss viable solutions interactively.

The iterative approach of starting with a comprehensive questionnaire and then focusing on key thematic questions in interviews proved valuable, as it helped saturate insights on main challenges (e.g., bureaucracy and lack of integration among sectors) while allowing participants the freedom to highlight unique perspectives. The workshop as a culminating activity was beneficial for synthesizing findings across stakeholders and identifying actionable recommendations.

In future iterations, simplifying the questionnaire to focus on essential points might help to streamline responses.

10 MONTENEGRO – National Report

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SUMMARY IN MONTENEGRIN

Oslanjajući se na proces evropskih integracija, Vlada Crne Gore, svoj rad bazira na sedam razvojnih stubova, među kojima zelena ekonomija, digitalna transformacija, regionalna saradnja i povezanost, unapređenje konkurentnosti, socijalna zaštita, društvo jednakih mogućnosti i dobro upravljanje. U tom kontekstu, strateški razvojni cilj Crne Gore je definisan kao: pametan, održiv i inkluzivan ekonomski rast, koji će doprinijeti smanjenju razvojnog dispariteta zemlje u odnosu na prosjek EU, oporavku i poboljšanju konkurentnosti realnog sektora, kao i povećanju kvalitetu života svih građana.

Uspješna zelena transformacija mogla bi nam pomoći da ispunimo Ciljeve održivog razvoja, ciljeve Pariskog klimatskog sporazuma, ambicije Evropskog zelenog dogovora i dostignemo ciljeve za smanjenje emisije CO2 u Evropi do 2050. godine. Uspostavljanje zelene i cirkularne ekonomije u Crnoj Gori uslovljava smanjenu upotrebu prirodnih resursa i stvara uslove za efikasnu upotrebu resursa, produžetak životnog ciklusa proizvoda, ponovnu upotrebu, obnavljanje i preradu, i reciklažu materijala.

Proces tranzicije je složen i zahtijeva integraciju različitih mehanizama. Zahtijeva saradnju svih važnih aktera na različitim nivoima lanca vrijednosti.

Ipak, Crna Gora pokazuje veliku potrebu za interdisciplinarnim istraživanjima u oblasti održivosti, posebno u oblastima cirkularne ekonomije, biodiverziteta i klimatskih promjena.

Promocija međusektorskih pitanja kao što su socio-ekonomski uslovi, uvođenje ESG standarda, promocija digitalizacije sve se više razmatra u oblasti finansiranja.

Dodatno, Vlada će razviti mehanizme finansiranja koji će biti ponuđeni malim i srednjim preduzećima, mobilisati sredstva u skladu sa tim, i pažljivo planirati finansijske šeme. Finansijska podrška će biti pružena onim malim i srednjim preduzećima koja su spremna da svoje postojeće poslovanje transformišu u zeleno ili od samog početka osnuju zeleno poslovanje.

Postoji potreba za prevazilaženjem otpora transformaciji i razvojem infrastrukture ka cirkularnoj ekonomiji. Potreba za optimiziranim strukturama upravljanja prepoznata je kao ključna za promovisanje međusektorske saradnje.

Na nacionalnoj radionici u kojoj su učestvovali svi zainteresovani akteri, razgovaralo se o potrebi pojednostavljenja i optimizacije regulatornog okvira i strukture upravljanja kako bi se prevazišao uvrežen otpor društva prema održivoj transformaciji.

Postignuta je saglasnost o potrebi jačanja međusektorske saradnje. Učesnici su razgovarali o tome koliko je važno stvoriti širu prihvaćenost održivog razvoja i riješiti nesklad između optimizacije i ekonomskih posljedica.

SRIA (Strateška agenda za istraživanje i razvoj

Crna Gora je usvojila nekoliko važnih krovnih strateških dokumenata – Program pristupanja EU, Program ekonomskih reformi (ERP) i Nacionalnu strategiju održivog razvoja (NSOR). Svi ovi dokumenti prepoznaju zelenu ekonomiju i održivi razvoj kao prioritete. Crna Gora implementira različite strategije i akcione planove za promovisanje održivosti i rješavanje ekoloških izazova.

Ključni dokumenti koji usmjeravaju ove politike i inicijative su: S3 Strategija, Strategija naučnoistraživačke djelatnosti Crne Gore 2024-2028, Strategija upravljanja otpadom do 2030. godine, Industrijska politika Crne Gore 2024-2028 i Nacionalna strategija za podsticaj cirkularne tranzicije do 2030.

Opcije finansiranja istraživanje održivosti u Crnoj Gori

Istraživanje održivosti u Crnoj Gori uglavnom se finansira od strane državnih organa, posebno ministarstva kao što su Ministarstvo prosvjete, nauke i inovacija, Ministarstvo ekonomskog razvoja, Ministarstvo energetike, Fond za inovacije i Eko fond. Vlada je 2024. godine obezbijedila oko 3 mil. Euro za projekte u oblastima obnovljivih izvora energije i životne sredine. Postoje i značajni programi kao što su: Program za unapređenje konkurentnosti privrede, koji ima ukupan budžet od 3 mil. Euro, Program kolaborativnih grantova za inovacije ima za cilj da podstakne mikro, mala i srednja preduzeća da aktivno i smisleno sarađuju sa „organizacijama za istraživanje i širenje znanja" ili „istraživačkim organizacijama", sa ukupnim budžetom od 1 mil. Euro.

Na CASRI radionici, učesnici su istakli neophodnost zajedničkog finansijskog planiranja između zainteresovanih aktera.

Pored toga, učesnici su imali priliku da uz kreativan pristup, kao način za rješavanje problema i kao ideje za EU projekte, isprobaju osnovne tehnike za kreiranje prijedloga projekta za aktuelne i buduće programe EU, posebno otvarajući vrata širokom spektru potprograma.

Relevantni aspekti interakcije između naučne politike i prakse SPPI

Za efikasnu koordinaciju implementacije mjera politike neophodno je obezbijediti multisektorski pristup. Potrebna je veća koordinacija između nacionalnih i regionalnih politika i strategija kako bi se osigurala doslijednost i efikasna implementacija. Sinergija i aktivno učešće lokalnih zajednica, preduzeća i drugih zainteresovanih strana u procesima donošenja odluka i istraživačkim aktivnostima osigurava da su predložene strategije izvodljive i da mogu zadovoljiti specifične lokalne potrebe. Osim toga, napori da se osigura kvalitetno prikupljanje podataka, upravljanje i razmjena između institucija i organizacija su od suštinskog značaja za podršku odlukama zasnovanim na dokazima.

Zaključak

Crna Gora mora da ostane u potpunosti posvećena implementaciji Plana rasta za Zapadni Balkan, koji će se fokusirati na održivi razvoj, inovacije i inkluzivne ekonomske politike.

Inicijative za jačanje saradnje, jačanje kapaciteta i podsticanje razmjene znanja od ključnog su značaja za jačanje i osnaživanje svake ekonomije Zapadnog Balkana.

EXECUTIVE SUMMARY ENGLISH

Montenegrin Government intends to base work on seven development pillars, relying on the EU integration process, as follows: green economy, digital transformation, regional cooperation and connectivity, improvement of competitiveness, social protection, equal opportunities society, and good governance. Against this backdrop, the strategic development objective of Montenegro is defined as: smart, sustainable and inclusive economic growth that will contribute to reduction in development gap of the country against the EU average, recovery and improved competitiveness of the real sector, as well as increased quality of life for all its citizens.

A successful transformation to a green economy could help us to meet the Sustainable Development Goals, the Paris Climate Agreement targets, the ambitions of the European Green Deal and reach carbon neutrality in Europe by 2050. Achieving this transition to a green and circular economy in Montenegro depends on reducing resource use, adopting and upscaling the lengthening of the useful life of products, reuse and shared use of products, repair and remanufacturing, and the recycling of materials.

The transition process is complex and requires the integration of various mechanisms. It requires the cooperation of all-important stakeholders and actors at different levels of the value chain.

Nevertheless, Montenegro shows a great need for interdisciplinary research in the field of sustainability, particularly in the areas of circular economy, biodiversity and climate change.

The promotion of cross-cutting issues such as the socio-economic framework conditions, introducing ESG standards, promotion of digitalization is increasingly being considered in the funding landscape.

The Government has aim to develop financing mechanisms that will be offered to SMEs, mobilize the funds accordingly and carefully plan financial schemes. The financial support will be provided to those SMEs that are willing to transform their existing businesses into green ones, or establish a green business from the very beginning.

There is a need for overcoming resistance to transformation and the development of infrastructure for the circular economy. The need for optimized governance structures was seen as crucial to promote cross-sector collaboration.

At the National Stakeholder Workshop, the participants discussed the need to simplify and optimize regulatory frameworks and governance structures in order to overcome society's established resistance to sustainable transformation.

There was consensus on the need to strengthen cross-sector collaboration. The participants discussed how important it is to create broader acceptance for sustainable forms of business and to address the discrepancy between microeconomic decisions and economic consequences.

SRIA

Montenegro adopted several most important umbrella strategic documents - EU Accession Program, Economic Reform Program (ERP) and National Sustainable Development Strategy (NSSD). All these documents recognize green economy and sustainable development as priorities. Montenegro has implemented various strategies and action plans to promote sustainability and address environmental challenges.

Key documents guiding these policies and initiatives include the S3 Strategy, the Strategy for Scientific Research Activity of Montenegro 2024-2028, Waste Management Strategy until 2030, The Industrial Policy of Montenegro 2024-2028, Montenegro and The National Strategy for Circular Transition until 2030.

Funding options for sustainability research in Montenegro

Sustainability research in Montenegro is mainly funded by state actors, in particular by ministries such as the Ministry of Education, Science and Innovation, Ministry of Economic Development, Ministry of Energy, Innovation Fund, and Eco Fund. In 2024, the government provided around 3 million euros for the projects in the fields of renewable energies and the environment. There are also important programs such Program for improving the competitiveness of the economy, which has a total volume of 3 million euros, the Program for Collaborative grants aims to encourage micro, small and medium-sized enterprises to actively and meaningfully collaborate with “research and knowledge dissemination organizations” or “research organizations“ with total amount of 1 million euros.

At the CASRI workshop, participants emphasized the need for joint financial planning between all stakeholders.

Additionally, participants had opportunity to practice creativity as a way of solving problems and as an idea for EU projects, basic techniques for designing a project proposal for the actual and future EU programs, especially opening the door to a wide range of sub-programs.

Relevant aspects of the interaction between science policy and practice SPPI

It is necessary to provide a multisectoral approach for efficient coordination of the implementation of policy measures. Greater coordination between national and regional policies and strategies is needed to ensure consistency and effective implementation. The synergy and active participation of local communities, businesses and other stakeholders in decision-making processes and research activities ensures that proposed strategies feasible and meet specific local needs. addition, efforts to ensure quality data collection, management and exchange between institutions and organizations are essential to support evidence-based decisions.

Conclusion

Montenegro has to stay fully committed to implementing the Growth plan for Western Balkan, which will focus on sustainable development, innovation, and inclusive economic policies.

Initiatives to strengthen cooperation, strengthen capacities and encourage the exchange of knowledge are of key importance for the strengthening and empowerment of each Western Balkan economy.

10.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

10.1.1. National research context

According to the primary result of OECD Western Balkans Competitiveness Outlook 2024: “Montenegro has improved its performance in the science, technology and innovation (STI) dimension since the previous Competitiveness Outlook assessment and scores above the regional average. According to the European Innovation Scoreboard (EIS), in which Montenegro participated in 2020 for the first time, the economy is an emerging innovator in 2023 with a performance at 47% of the EU average (EIS, 2023[1]). Compared to the previous assessment, the gap between Montenegro and the EU average is widening as the possible impact of recent policies has yet to materialise. Overall research and innovation capacity remain low in Montenegro. Investments in R&D remain nascent and, in the absence of reliable data on gross expenditure on research and development (GERD), challenging to monitor. In addition, the number of scientific research projects remains stagnant and to date, Montenegro has only submitted one successful patent application to the European Patent Office, suggesting shortcomings particularly about the quality of scientific research. Montenegro has created a framework for the implementation of innovations and smart specialisation based on the proposal of the Directorate-General Joint Research Centre (DG JRC) of the European Commission, considering the particularities of the Montenegrin ecosystem. The Smart Specialisation Strategy (2019-24), in line with good practice, does entail such SMART key performance indicators, which are regularly reviewed. Montenegro has adopted a two-phased Programme for Innovation for the periods 2021-24 and 2023- 27, aimed at creating a single space for implementation of all innovation support programmes. In the absence of a strategic framework, this programme is an important mechanism to maintain momentum gained in recent years in advancing Montenegro’s STI framework”.

Montenegro opened negotiations for Chapter 27 – Environment and Climate Change in December 2018, as one of the most significant chapters in the country's negotiation process. An ambitious goal was set as a high priority for the country – achieving EU ecological standards.

Montenegro is one of the first countries in the Balkans to demonstrate its commitment to combating climate change by reducing CO2 emissions (30% by 2030), working both internationally and nationally to accelerate the implementation of climate change measures through clean energy, clean technology, and a renewed focus on green infrastructure and the development of the green economy. Although a relatively small country with fewer than a million inhabitants, Montenegro is part of a group of only 16 countries, out of a total of 197 globally, that have already met this target.

The ecological, economic, and social aspects of Montenegro's development in recent decades indicate that the needs of future generations may be threatened not only by the qualitative and quantitative degradation of natural resources but also by the decreasing availability of other resources.

In recent periods numerous projects have been implemented with the goal of raising awareness among business sector representatives, especially small and medium-sized enterprises, about the importance of concepts such as green economy, circular economy, sustainable consumption and production, etc. These projects were mainly carried out by relevant ministries, the Chamber of Commerce of Economy, business associations, and non-governmental organizations. However, there is a clear need for continuous promotion of these concepts, in terms of the benefits they bring

to SMEs, as well as the financing opportunities for green economy investments from state sources, the Environmental Fund, the Investment and Development Fund, Innovation Fund, international donors, and commercial banks managing international credit lines intended for the green economy.

Adapting to new challenges and changing circumstances requires the implementation of serious systemic reforms, focusing on two key acceleration mechanisms - circular transition and digital transformation, which will enable the introduction of new business processes and easier adaptation to new market circumstances.

The Montenegrin Government established a Innovation Fund. The aim of the Fund is to provide financial support to innovative ideas and therefore to direct Montenegro toward technological development. Furthermore, the government has established an Eco Fund with the purpose to finance and provide technical support to projects/programs in the field of the environment, climate change and energy.

Additionally, various ministries support research in sustainability and environmental protection, including through grants and technical assistance.

The transition to greener economies requires aligning stakeholder interactions and decision-making mechanisms with environmental imperatives. Considering this, Competitiveness Council of Montenegro has formed the “Green Economy” Working group (GE WG) in order to promote green economic development, enhance greening activities, design and implement measure and activities defined in AP of the Strategy for Promotion of Circular Transition until 2030. Members of the GE WG are representatives of the relevant ministries/institutions, international institutions and donors, business associations and NGO.

The pooling of public and private resources at the national and regional levels should be strategically coordinated, with these joint investments primarily directed towards industrial development and the commercialization of new business technologies, mapping and development of "smart" skills, increasing investment in innovation, and strengthening the innovative potential of the business sector, with an emphasis on enhancing cooperation at all levels and establishing public-private partnerships.

10.1.2 Resilient, net-zero, circular production systems

Infrastructure for separate waste collection and recycling exists, however it is not used properly by citizens, and illegal and temporary waste disposal have yet to be resolved. The legal framework in Montenegro is guided by the new Law on Waste Management, which aims to transpose the EU waste legislation, adopted by the Parliament of Montenegro in April 2024. It is expected that an extended producer responsibility (EPR) scheme, prescribed in the Law on Waste Management will be implemented until 2030. Considerable efforts on strategic planning and investment are needed to implement the national Strategy for waste management until 2030. Amongst other issues this new Law bans the use of lightweight plastic carrier bags at retail establishments, and introduces the extended producer responsibility program. The National Strategy for Circular Transition until 2030 with the accompanying Action Plan for the period 2023-2024 has been created. These have the aim to create conditions for accelerated economic development and further strengthen the resilience of the Montenegrin economy to global challenges, The Strategy represents the basis and infrastructure for the future developing of the economy and supports the improvement of the investment climate in

Montenegro, guided by the principles of economic, social and ecological sustainability. The goal was to create mechanisms and an implementation tool for Montenegro's long-term recovery and resilience, in consultation with all relevant stakeholders, through an open, participatory process.

Agriculture, forestry, construction, and tourism are not only recognized as key development sectors of the Montenegrin economy, but also as priority areas for a circular transition that, due to identified synergies, can bring systemic changes to Montenegro.

On the other hand, production, technological development and innovation, sustainable financing, energy efficiency, green public procurement, waste management, and the education and promotion of the circular economy concept represent horizontal areas and essential prerequisites for the circular transition of the Montenegrin economy, as well as for each of the four development sectors.

The processing sector is crucial for the development of the economy's competitiveness in regional and international markets. Policymakers have recognized the potential for increasing competitiveness through diversification, innovation, technology transfer, and improving resource efficiency, prioritizing these areas in various national strategic documents. Therefore, transforming the Montenegrin processing sector from linear production to circular value systems could present a significant opportunity to achieve the set goals.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Sustainable Agriculture and long term Food Security - sustainable agricultural practices in the face of climate change.	A,T,S	Short term: Increased agricultural productivity and resilience to climate impacts. Long term: Sustainable food systems that ensure food security for future generations. Production of healthy and nutritionally rich food with less (or completely without) application of artificial fertilizers and pests/herbs/insects and other "cides".	R,N
Waste management and reducing environmental pollution – a problem of regional and national importance	S, A	Long term: Reduction of the total amount of waste disposed of at the landfill Short term: Collection, separation and recycling of solid waste Extended Producer Responsibility (EPR) concept	R,N, E
Green public procurement	S, A	Short term: promote the adoption of Green Public Procurement (GPP) in order to overcome the barriers that hamper the transition towards circular economy. Long term: develop macro-regional solutions and boost the demand and offer of CE products and services.	N, E
Important for urban resilience, climate adaptation, and biodiversity enhancement	S	Montenegro will develop further green, inclusive, accessible, affordable and sustainable public transport in accordance with the needs of all categories of the population in order to improve the quality of life and protect the environment. Long term: set up a systematic review of the development of the concept of carrying capacity in tourism, to elucidate the methodological point of view in terms of the definition and evaluation of carrying capacity, and to determine the relation between tourism carrying capacity concept and spatial planning.	R, N, E

		A tourism carrying capacity thesis is also presented as an active method for planning, control and evaluation of tourism activity.	
Circular Economy Integration in society – Enhance resource efficiency, reduce waste and promote sustainable resource use, essential for long-term environmental sustainability.	A, T	Short term: Reduced waste and resource consumption. Long term: Sustainable development with minimal environmental impact.	N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

10.1.2. Biodiversity and climate

Climate change and its negative impacts are affecting all countries around the world, including Montenegro. Understanding how our climate is changing, and the potential impact, is of key importance for directing future activities that we need to implement to further reduce GHG emissions. Over the past ten years, Montenegro has made more progress in further aligning national legislation with the EU-acquis on water, nature protection and climate change; with reducing greenhouse gas emissions, transforming its energy system, and reducing its pollution load. Montenegro has a climate Strategy in place, but has to intensify its work to ensure consistency with the EU 2030 Climate and energy policy framework. The work on the development of the national energy and climate plan continues, finalization is expected by mid-2024. The Third Biennial Climate Change Report (TBUR), adopted in December 2021, has additionally strengthened national capacities, partnerships and cooperation with related sectors. It has improved general knowledge, increased the participation of all relevant stakeholders, and increased awareness of climate change and its impacts. The report has been finalized with revised calculations of GHG emissions for the period 1990-2019, in line with the new methodology of the 2006 IPCC Intergovernmental Panel on Climate Change. In February 2023, the National Council for Sustainable Development set up a permanent working group for mitigation and adaptation to climate change, with the aim to set up a monitoring and reporting system for GHG emissions and to prepare policies and measures in accordance with the EU-acquis. The EU Carbon Border Adjustment Mechanism that entered into force in its transitional phase on 1 October 2023.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need/*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Environmental protection of mountain ecosystems	S, A	Enhanced resilience of mountain ecosystems to climate variability. Long term: Preservation of mountain biodiversity and ecosystem services.	R, N, E
Climate Resilience and National adaption Plan - Climate change poses significant risks to long-term development of Montenegro.	S, A	Long term: develop a long-term adaptation planning process that is anchored in the National Climate Change Strategy by 2030 and recent Montenegro's National Communication. Strengthen institutional framework, expand technical capacities of those responsible and involved in climate change adaptation planning, improve the information base needed for effective decision-making and define a resource mobilization strategy. Reducing CO2 emission on 50% until 2030. 0% CO2 emissions until 2050 The green transition of Montenegro will be fair and equitable, based on clear and comprehensive strategies that identify key sectors and areas that are most sensitive to climate change and disaster risks, on increasing investment in research and development with the application of digitization, innovation and inclusiveness in order to achieve climate neutral economy, at the level of reducing greenhouse gas emissions by up to 55% by 2030 compared to emissions in 1990 (obligations undertaken at the international level, in the Energy Community decision of December 2022).	N, R
Climate change and biodiversity – the priority is urgent and important because of the unprecedently fast changes in global and local climate and inability of ecosystems to react within a short time	S	In short term – action plans for conservation of fragile and endangered ecosystems and species	R, N, E

		In long term – change of the national and international (European) concepts and policies for energy supply and utilization of natural resources	
Sustainable Forest Management and Reforestation -	S, A	Stabilization of forest ecosystems and reduction of deforestation rates.	N, E
Development of Nature-based Solutions for Climate Mitigation and Adaptation -	A, T	In long term - Widespread adoption of nature-based solutions that enhance climate resilience and biodiversity.	N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

10.1.3 Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Smart City Technologies and Digitalization of Urban Services - Urgent to improve the efficiency, sustainability, and liveability of urban areas in Montenegro	A, T	Long term: Fully integrated smart cities with data-driven governance and high quality of life.	R, N, E
Urban Green Infrastructure Development - Enhance the resilience of infrastructure against climate change impacts	S, A	Long term: Climate-resilient infrastructure that supports sustainable development and reduces vulnerability to climate-related risks.	R, N
Climate Adaptation and Resilience in Urban Planning - Important to ensure that cities are prepared for and resilient to the impacts of climate change, including extreme weather events.	S, A	Long term: Cities that are adaptable and resilient to long-term climate changes, safeguarding communities and infrastructure.	N, E
Nature-based Solutions	S	Long term: Improved urban resilience, better quality of life	

Urban Transport Infrastructure Development -	A, T	Short term: Develop further green, inclusive, accessible, affordable and sustainable public transport Long term: Improve the quality of life and protect the environment.	R, N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

10.1.4. Nature & environmentally friendly energy transition

The process of revising the Nationally Determined Contribution (NDC) has been completed. A new goal for reducing GHG emissions set by 35% by 2030 compared to 1990. Montenegro has also initiated development of the National Adaptation Plan (NAP), in order to identify medium- and long-term needs for adaptation to climate change and to establish a coordination system for implementation of climate change adaptation measures. Respective ministries have continued to work on the National Energy and Climate Plan (NECP), a draft of which is nearly complete. The plan will enable the implementation of necessary measures to meet the strategic goals by 2030. Transition to a low-carbon economy by 2050 is still our goal. Progress has been made in the development of spatial plans and environmental impact assessments for the implementation of wind farms and solar power plants.

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Cross-Border Energy Collaboration in the Balkans - Important to enhance regional energy security and cooperation, particularly in integrating renewable energy sources across borders.	S, A	Improved regional energy collaboration on renewable projects and energy transition to improve energy security and reach goals set for a sustainable energy transition.	R, N, E
Just transition: local needs, participation, e.g. energy communities, socio-economic enterprises, social governance	T, A	Increased public awareness and participation in the energy transition. Understanding the factors affecting R&D trends in the energy sector - Public Engagement, Education.	R, N
Policy and Regulatory Frameworks for Sustainable Energy Transition	S, T	Encourage innovations in the function of energy efficiency in different sectors. Implementation of supportive policies and enforcement of legal provisions.	N, E
Improved Energy Efficiency in Buildings and Infrastructure -	A, T	Reduce energy consumption and meet energy demand more efficiently	R, N
Renewable Energy Transition - reduce carbon emissions and combat climate change, ensuring energy security and sustainability.	S, A	Short term: Increased use of renewable energy sources. Long term: Carbon-neutral energy systems and significant reduction in global greenhouse gas emissions. Reducing CO_2 emission on 50% until 2030. 0% CO_2 emissions until 2050. Montenegro will undertake effective activities to increase energy efficiency and improve its energy mix, especially in terms of gradually reducing the use of fossil fuels in energy production and consumption and accelerating the use of renewable energy sources, and will adopt socio-economic measures that will reduce the energy poverty risks.	N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

10.1.5. Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Sustainable Economic Development	A, T	Development of sustainable business models and practices.	R, N, E
Foster collaboration between research institutions, industry, and government.	S, T	Improved collaboration and knowledge transfer among innovation stakeholders. Create a robust innovation ecosystem that drives sustained economic growth and global competitiveness	N, E
Digital Transformation for Sustainable Development - Important to leverage digital technologies for sustainability, enhancing efficiency and innovation in various sectors.	T, A	Short term: Improved efficiency and innovation in key sectors. Long term: Widespread adoption of digital technologies driving sustainable development across industries.	N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

10.2 Promising funding schemes

The following collaborative funding schemes were seen as particularly effective or promising by interview partners:

- Horizon Europe was highlighted as an important milestone in the EU-Montenegro cooperation in the field of research and innovation and as a crucial building block towards its closer European integration. It is particularly effective because it supports large-scale collaborative projects and fostering cross-border cooperation.
- Interreg Europe is designed to facilitate cooperation between European regions, enabling them to share experiences and learn from each other. This programme promotes the exchange of best practices and innovative solutions to common regional challenges.
- Interreg IPA - The cooperation within Interreg IPA (Instrument for Pre-Accession Assistance) includes 14 programmes covering cooperation in 212 regions between EU Member States and candidate countries. Interreg IPA fosters social, economic and territorial cohesion, supports candidate countries for future EU membership through mutual learning and good neighbourly relations.

10.3 Improving the Science Practice Policy interface (SPPI)

Montenegro has already conducted two cycles of mapping the scientific impact of research infrastructure in 2015 and 2019, and the Ministry of Education, Science and Innovation launched the third research infrastructure mapping process for the research infrastructure of Montenegro 2024-2028.

The Government of Montenegro has adopted the Strategy on Scientific Research Activities (2024-28). The main goal is a significant improvement efficiency and effectiveness of scientific research activities, as well as contribution to the development of the economy through improvement quality of science and research and further integration into ERA, which will enable the creation of stimulating and sustainable research environment that encourages innovation, supports young researchers and promotes synergy between science and business.

Montenegro established an Innovation Fund in 2021, which is now fully operational. With capacity-building support provided by the World Bank with funding from the EU, UNDP and Norway, the Innovation Fund is on track to become Montenegro's key vehicle for innovation policy implementation.

The Science and Technology Park of Montenegro had a grand opening on June 11, 2024.

Through joint projects and appropriate research/innovative infrastructure, academic and private sectors can work on enabling quicker transformation of the scientific findings into commercially applicable products and services.

For the economy it is necessary to provide quality targeted support through the mechanism of collaborative projects, where through supporting applied and developmental research, scientific research activity for the market needs are encouraged.

10.4 Recommendations for CASRI by NKS

The CASRI SRIA should pay attention to:

- Enhancing Cross-Border Environmental Cooperation;
- Strengthening Innovation Ecosystems;
- Public Engagement, Education, of the circular economy integration in society – enhance resource efficiency, reduce waste and promote sustainable resource use, essential for long-term environmental sustainability;
- Fostering excellence, collaboration and innovation through collaborative funding scheme.

10.5 Reflection on the workflow

The report is based on interviews, workshop, and desk research conducted by the CASRI team in Montenegro. The desk research relied on four pre-defined CASRI topics and was used to define the basis for conducting the interviews. Saturation of responses became evident after the first few interviews. Each interview provided interesting individual insights, but the main themes and findings, especially regarding challenges and weaknesses, continued to resurface. In future iterations, simplifying the questionnaire to focus on essential points earlier might streamline responses.

A total of 14 national key stakeholders were interviewed on the topic of sustainability and innovation research. The interviews were based on the initial results of the desk study, which compared and reviewed a wide range of documents. The desk study provided a broad and structured overview of available literature, focusing on established frameworks, national and international reports, and predefined funding mechanisms.

The interviews followed a semi-structured survey approach using a questionnaire provided by CASRI. The interviewees are representative of the research organization, end-users of knowledge, knowledge producers. The interviews were conducted face-to-face.

The main purpose of the workshop was to prioritize and elaborate the potential topics for SRIA and discuss the initial findings. The participants involved were experts with many years of professional experience in the fields of environmental research, sustainability, financing, and various research and innovation topics.

The workshop allowed for real-time collaboration, bringing to light recurring themes, such as the need for coordinated funding approaches and streamlined administrative processes. It also reinforced a consensus on themes where existing funding was insufficient, and participants could share best practices and discuss viable solutions interactively.

The workshop was useful for synthesizing findings among stakeholders and identifying actionable recommendations.

The results presented here aim to help determination of the priorities and potential key issues from a Montenegrin perspective.

11 THE NETHERLANDS – National Report

Authors: Mariësse van Sluisveld, Anton van Hoorn, Leonora Verveld

Country report specific abbreviations

MTIB	Mission-oriented Topsectors and Innovation Policy
NWA	National Research Agenda
NWO	Dutch Research Council
RVO	Netherlands Enterprise Agency
TO2	Applied science institutes

SUMMARY IN DUTCH

In Nederland wordt onderzoek en innovatie aangestuurd door algemene beleidsrichtlijnen die naast onderzoek en innovatie ook op ondernemerschap zijn gericht. De belangrijkste doelen, traditioneel gezien: 1) verdienvermogen; 2) veiligheid, en; 3) concurrentiekracht. Duurzaamheid wordt geïntegreerd via maatschappelijke missies en specifieke beleidsdoelen en -strategieën op dit thema. Invloeden van buitenaf, zoals het Klimaatakkoord van Parijs, de ‘Sustainable Development Goals’ (SDG’s), en de Europese ‘Green Deal’, spelen ook een rol. Ze leggen eisen op aan verschillende organisaties en sectoren. Dit veroorzaakt soms spanning tussen de traditionele innovatiedoelen en de milieudoelen of maatschappelijke missies. In dit rapport analyseren we vier doorsnijdende uitdagingen voor onderzoek en innovatie (ES O&I) op het gebied van milieu en duurzaamheid. Het belangrijkste doel: in kaart brengen welke kennisontwikkeling het meest nodig is op dat snijdvlak. Dit als invoer voor strategische kennis- en innovatieagenda’s.

Over het algemeen is de aanpak van onderzoek en innovatie in Nederland meer gericht op economische en technische projecten dan op bredere mens- en maatschappijgerichte veranderingen in de samenleving. De primaat van bestaande innovatieprogramma’s ligt hiermee vooral bij technologische oplossingen op bijvoorbeeld de CASRI thema’s 'veerkrachtige, circulaire en klimaatneutrale productiesystemen' en 'natuurinclusieve energietransities'. Door het ontbreken van een bredere, meer systemische aanpak ontstaan er steeds meer vragen over hoe beleid beter kan worden afgestemd, gecoördineerd en geïntegreerd. Dit speelt vooral wanneer er geen duidelijke doelen of meetbare effecten zijn, wat bijvoorbeeld het geval is bij natuur- en biodiversiteitskwesties, of waar verschillende doelen samenkomen, zoals bij het CASRI-thema 'duurzame verstedelijking'. E.e.a wordt bemoeilijk door het feit dat er voor de verschillende milieudoelen parallelle kennis- en innovatie-ecosystemen bestaan.

Om deze samenhangende problemen aan te pakken, zo wijst voorliggende analyse uit, is er een lange-termijn commitment nodig binnen zowel wetenschap als beleid. Wetenschap moet meer van theorie naar praktijk gaan, en beleid moet flexibeler met complexiteit omgaan en voorkomen dat verschillende onderdelen langs elkaar heen werken. De sleutel ligt in het beter gebruiken van

bestaande middelen en systemen (meer integraal, beter afgestemd), niet zozeer in het aanwenden van meer fondsen of nieuwe aansturende instituties.

Een strategische kennis- en innovatieagenda die aangedreven en afgestemd wordt vanuit de verschillende milieuagentschappen in Europa biedt landen de kans om van elkaar te leren over hoe beleidsdomeinen het beste kunnen worden geïntegreerd en welke institutionele inrichtingen het beste werken om een duurzamere verandering teweeg te brengen. Door bestaande expert gemeenschappen (netwerken van kennisvragers, aanbieders en 'funders') hiervoor te mobiliseren wordt tot een toegespitste vraagarticulatie gekomen die aansluit op potentieel kennisaanbod en 'funding'.

EXECUTIVE SUMMAY ENGLISH

In the Netherlands, research and innovation (R&I) policy is traditionally combined with policies aimed at promoting (strategic) entrepreneurship. The key objectives: 1) earning capacity; 2) security, and; 3) competitiveness. Sustainability goals are integrated via specifically formulated societal missions and a plethora of policy objectives (binding and aspirational) and strategies. Supranational influences on these themes are imposed via e.g. the international Paris Climate Agreement, Sustainable Development Goals, European Green Deal, or via directives imposing specific conditions on (societal) actors. This leads to friction between the traditional innovation objectives on the one hand and the established societal missions or environmental policy objectives on the other. This report analyses four cross-cutting challenges for research and innovation (R&I) in the field of environment and sustainability The main goal: to identify and prioritize the main ES-R&I needs in these fields. This serves as input for strategic knowledge and innovation agendas (SRIAs).

Overall, R&I planning in the Netherlands is economic-engineering-centred, with a project-based orientation. This favours ES R&I challenges with technological transitions at their heart, such as the CASRI themes 'resilient, net-zero and circular production systems' and 'nature & environmentally friendly energy transitions'. This lack of a systemic, holistic approach, including the human and societal dimension, leads to an accumulation of (knowledge) needs like 'coherence', 'alignment', 'coordination', 'mainstreaming' and 'prioritisation' across the administrative layers. This particularly goes for policy aspirations with targets that are hard to quantify of monetize like nature and biodiversity (e.g. 'nature & environmentally friendly energy transitions' or 'biodiversity & climate'). Multiple R&I ecosystems are maintained to cover diverging policy aspirations and claims. This strains effective policy implementation, especially where these different objectives intersect (e.g. in the case of the CASRI-themes 'sustainable urbanisation' or 'resilient, net-zero, circular production systems').

Moving beyond this sectoral, economic-engineering perspective requires a long-term commitment at both the science and policy side of the Science-Policy Interface (SPI). This analysis confirms that science needs to diversify and advance from theory to application, while policy needs to accommodate methods to embrace complexity and avoid silo formation. Cross-cutting challenges need integrated policy making and (national) funding, with clear 'ownership' on a departmental level. Rather than raising more and more funds and adding active bodies governing them, the current system should be better utilized (i.e. be better coordinated, integrated, aligned). An international strategic research and innovation agenda driven by environmental protection agencies may offer a

learning opportunity for utilizing the science-policy-practice interface better for various crosscutting themes.

Recommended venues are collecting best-practices across Europe in mainstreaming the integration of policy domains and comparing the institutional arrangements that excel or block transformative change. Leading expert communities can support the articulation of more detailed needs.

11.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

11.1.1. National Research Context

On a national level, research and innovation is guided by general policies that direct research (Dutch Government, 2022b), innovation (Dutch Government, 2022d) and (strategic) entrepreneurship (Dutch Government, 2022a, c). Traditionally the key objectives for R&I are: 1) earning capacity; 2) security, and; 3) competitiveness. Sustainability goals and conditions are integrated into this context via specific formulated societal missions (Dutch Government, 2023) and a plethora of policy objectives (binding and aspirational) and policy strategies (see Table *11-*able 11-1 for an illustrative representation). Supranational influences are also imposed via e.g. the international Paris Climate Agreement, Sustainable Development Goals, European Green Deal, or via directives imposing specific conditions to (societal) actors.

TABLE 11-1 - SIMPLIFIED OVERVIEW OF RELEVANT FACTORS IN THE NATIONAL SECTORAL POLICY CONTEXT SHAPING THE DIRECTIONALITY OF NATIONAL RESEARCH AND INNOVATION EFFORTS.

Theme	Mission statement	National policy objectives	Institutionalization	National policy programmes	National strategies	Other relevant aspects
Resilient, net zero, circular production systems	Energy Transition Circular Economy	Climate (Climate neutrality by 2050), Circularity (100% circularity in 2050), Energy transition (energy efficiency, renewable energy targets)	NL Climate law, NL Energy agreement NL Raw Materials agreement	National Programme for Energy Infrastructure (NPE) National Programme for Greening Industry (NPVI) National Programme for Circular Economy (NPCE)	National technology strategy National resources strategy	Active special ambassador 'resources strategy' Active special ambassador 'circular economy' IBO Climate
Nature-inclusive energy transition	Energy Transition	Climate (Carbon neutrality by 2050), Energy transition (energy efficiency, renewable energy targets) Halving ecological footprint	NL Climate law, NL Energy agreement	Programme Enhancing Biodiversity National Programme for Regional Energy Strategies (NPRES)	National technology strategy Vision document: Natuurambitie Grote Wateren 2050 en verder Netherlands nature-positive ambition	Sector agreement: Nature inclusive energy infrastructure
Biomass and climate	Agriculture, Water, Food securtiy	Climate (Carbon neutrality by 2050),	NL Climate law,	National Programma for Rural Area (NPLG) Programme Enhancing Biodiversity	National strategy and action plan biodiversity (NBSAP)	International attention (e.g. UN and EU level) IBO Biodiversity IBO Climate
Sustainable Urbanisation	None explicitly	Increased housing stock volume, climate neutral built environment, nature inclusive	None explicitly	Leerplatform MIRT MooiNL City deals		Collaborations, city deals IBO area

Theme	Mission statement	National policy objectives	Institutionalization	National policy programmes	National strategies	Other relevant aspects
		Resilient, healthy/liveable cities		Deltaplan spatial adaptation		

R&I infrastructure

In the Dutch R&I context a distinction can be made between top-down and bottom-up knowledge management. A top-down organization of ES R&I needs links knowledge needs to the task responsibility of a ministry or is part of general consultation for policy themes (referred to as 'knowledge for policy'). A more bottom-up approach ensures that public, private and societal actors collaborate to reach an articulated objective (referred to as 'knowledge for transitions') (Evaluatiecommissie TO2 2021). See Figure 11-1 for an illustrative representation.

Knowledge for policy

The Netherlands has an extensive system to inform policy with evidence-based information. Knowledge in the Dutch ministries is organized in a hybrid manner, with strong emphasis on decentralized allocation (per directorate) supported by a central staff department. With policy issues becoming increasingly cross-sectoral, new structures have been put into place to enhance cross-sectoral, cross departmental interaction. Amongst them are the interdepartmental meetings of "chief scientist officers' (CSO) and "directors" (IDO). The level of institutionalization differs per ministry and directorate. On a thematic level new structures have been put into place, including planning agencies and other research institutes (e.g. WUR) are included (IBO).

More formalized is the establishment of dedicated planning agencies and national labs (*Rijkskennisinstellingen*), advisory councils, other governmental services and sector/industry organizations supporting evidence-based policy making. The role and responsibilities of these institutions differ significantly, with different degrees of association to the ministries, different thematic focus areas or mandates (e.g. advisory, inspection and implementation organizations), and the ability to give invited or independent advice on governmental policies to the government (Diercks et al., 2016).

Knowledge for transitions

Since the late 2010s, the Netherlands has adopted a new form of R&I governance (referred to as 'Mission oriented top sectors and innovation policy', MTIB) that stimulates co-creation between public and private actors (public-private partnerships) for obtaining societal goals (including sustainability objectives).

Currently the sustainability objectives are captured in national missions and implemented into multiple executive programmes along the MTIB R&I infrastructure (named multi-annual mission-oriented innovation programmes, MMIPs, although semantics may differ per executive programme). Various funding schemes and incentives are allocated to nudge societal actors to engage in specific activities. These schemes can be policy specific (e.g. coupled to energy and innovation policy) or more generic in nature (van Wijk et al., 2023).

Specific 'mission teams' and pre-existing legal entities (referred to 'TKI' under MTIB) have been tasked with the implementation and coordination of (public-private) activities and direction of

knowledge development in executive programmes created under MTIB. Simultaneously, public investments are used to stimulate specific (economic) activities. For example, various national funds (e.g. National Growth Fund, National Research Agenda, Climate Fund, Transition Fund, Future Fund) run in parallel with each their own strategic purpose and organisation. Only few stakeholders operate (unsuspectingly or deliberately) in multiple ecosystems and across development phases (Chappin et al., 2021).

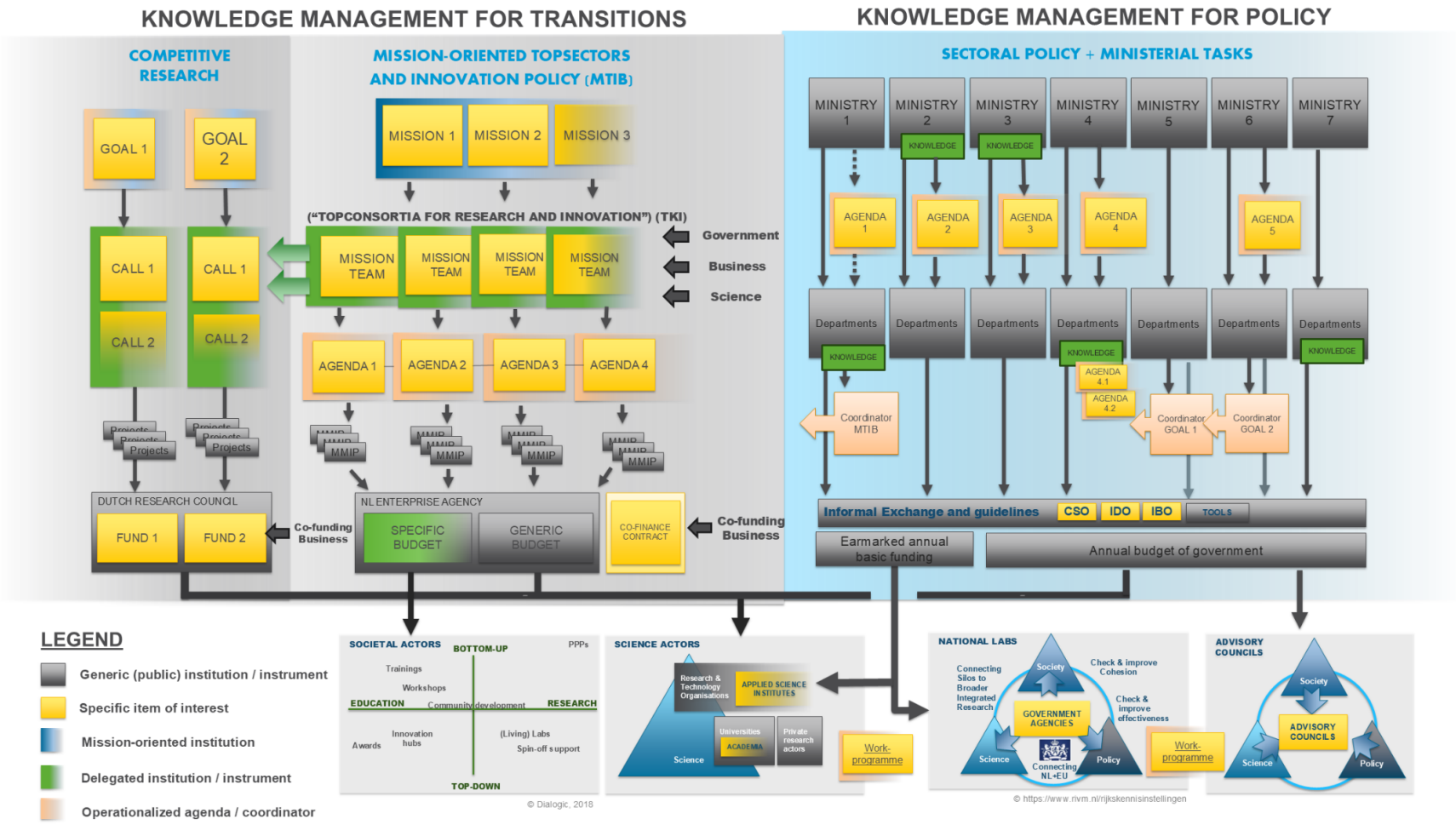

FIGURE 11-1 - NATIONAL LANDSCAPE ON KNOWLEDGE DEVELOPMENT FOR SOCIETAL SUSTAINABILITY CHALLENGES (INDISTINCTIVE OF DIFFERENCES PER KNOWLEDGE ECOSYSTEM)

Functioning of R&I policies for sustainability

As described in the above paragraphs, the Netherlands has fairly saturated and elaborate formal and informal systems in place to support the science-policy-practice interface on sustainability challenges. With the embedment of sustainability missions in the R&I policies, there is a connection of traditional R&I policies to the sectoral policies.

From a R&I policy perspective, knowledge needs, drivers and results are captured in a structured approach where strategic research and innovation agendas are periodically developed and executed through competitive research funding. In general the current configuration is considered more appropriate for economic-technological innovations than more broader mission-oriented developments (ABDTOPconsult, 2023; AWTI, 2023; D&B, 2022; JRC, 2023; Paradies et al., 2023; van Wijk et al., 2023). Specific funding, research and valorisation programmes have been launched simultaneously to cover the broader spectrum of societal challenges within the formal R&I structures (e.g. the appointment of a non-technological innovation TKI called CLICKNL), but also beyond the formal R&I structures (e.g. National Research Agenda). However, adequate knowledge development and uptake remains fairly low due to lack of engagement and absorption on the various sides of the science-policy-practice interface (ibid).

From a sectoral policy perspective, knowledge needs, drivers and results for crosscutting themes are less clearly pronounced. Each specific policy department may maintain their own research agenda and science-policy-practice networks. (Inter)departmental collaboration on knowledge management remains informal and unstructured, hindered by multiple administrative layers and the absence of clear responsibility (ABDTOPconsult, 2023). As a result, only more centrally developed research agendas are shared more publicly but infrequently, with a need for public research and advisory agencies to execute and deliver on it voluntarily. Momentum for specific cross-cutting themes may only be traceable through indirect data, such as the annual output of these public agencies or through personal communication with civil servants.

Knowledge needs in global view

By taking stock of the various knowledge agendas driven by, amongst others, innovation policy, sectoral policy and raised concerns in science and society, it is observed that there are many topical questions articulated on the range of proposed themes in the CASRI project (see Figure 11-2). Several general observations could be made through desk research and interviews:

- **Intersectionality:** In regards to crosscutting themes, not one dedicated national ES R&I research agenda could be found that combined the ES R&I challenge as proposed in the CASRI project. Elements addressing the combined challenges may, however, find application in competitive research programmes or work programmes within a wide range of intermediary, implementation, research or private organisations. Results are therefore scattered around multiple sources.
- **Transboundary:** a limited explicit scope on intergenerational or international questions has been observed in existing public research and innovation agendas, with more likelihood in targeted (policy) consultation. Various agendas may account for long-term policy targets as part of the context. Strategic considerations of surrounding countries or the link of national contexts to international ones are rarely addressed. Funds may be occasionally available for international collaboration but these stand on their own and are not necessarily tied to a specific agenda.

- **Transdisciplinary:** Experiential knowledge or broader engagement with citizens or stakeholders is described in the context of developing more robust transition processes. Questions along these lines are, however, not yet mainstream in the various research agendas across the innovation or sectoral policy developments.

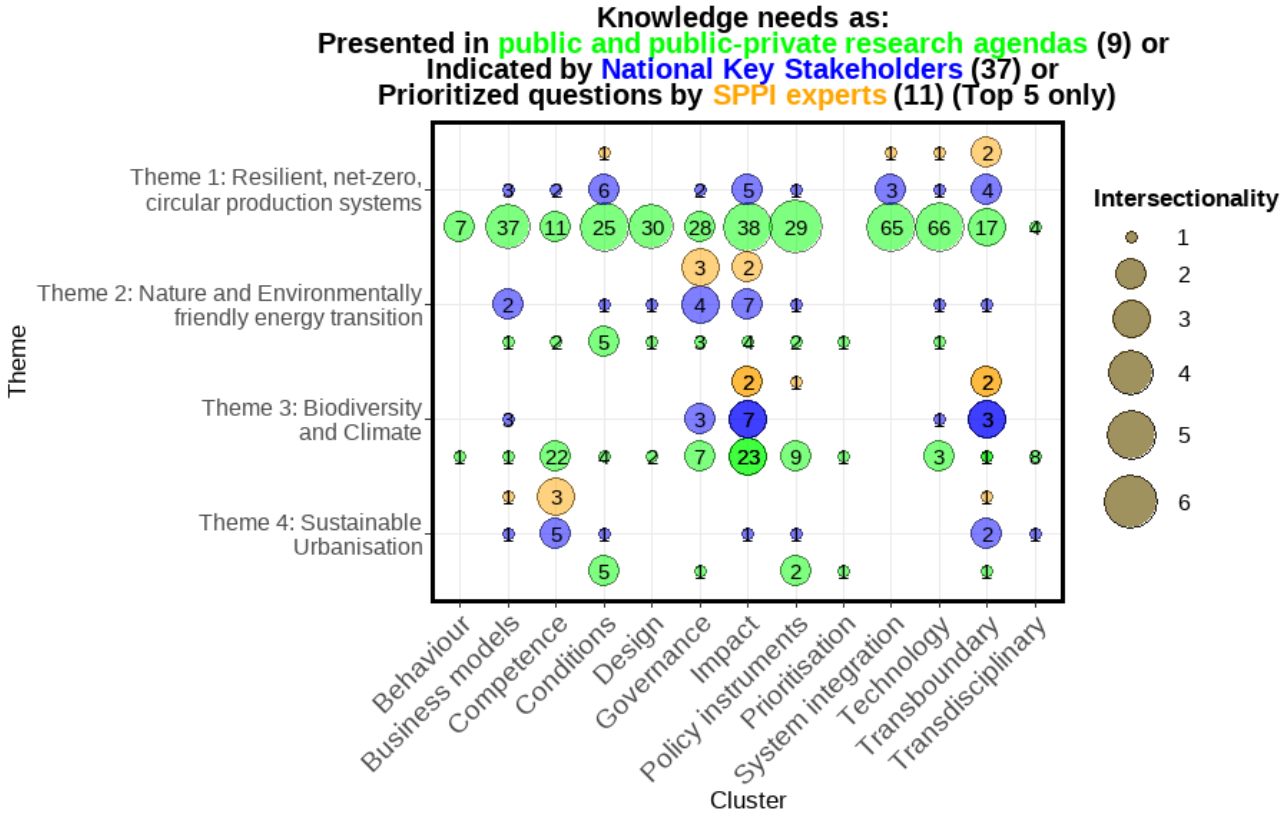

FIGURE 11-2 - ILLUSTRATION OF KNOWLEDGE NEEDS AS INDICATED IN PUBLIC AND PUBLIC-PRIVATE KNOWLEDGE AGENDAS, FROM INTERVIEWS & ASSESSED BY SPPI EXPERTS (PBL)

Intersectionality represents how often topics were mentioned across the various sources (different agendas and types of actors). Clusters are umbrella categories that cover questions related to societal change (behaviour), levelized playing field (business models), knowledge infrastructure needs for monitoring, sharing of information (competence), requirements, acceptance and thresholds (conditions), micro-level organisation (design), roles and responsibilities (governance), economic, environmental, human impacts (impacts), influence options like laws, regulations, stimuli (policy instruments), macro-level organisation (system integration), technological innovation (technology), intergenerational, international and multi-challenge problems (transboundary) and involvement of citizens and other actors (transdisciplinary).

11.1.2. Resilient, net-zero, circular production systems

This theme is covered by multiple innovation policy, environmental policy and security policy agendas. As a result there are various drivers active in parallel that stimulate strategic knowledge development with each its own objectives and participating ecosystems. In helicopter view the traditional R&I infrastructures have predominantly focused on energy conversion and infrastructural needs to comply with the energy and climate objectives (Chappin and Schipper, 2021). General concerns have been expressed that these centrally posed research needs are too aligned with private interests and focused on technological development only (Truijens et al., 2021). Other sectoral policies give impetus, although less visible to other knowledge developments in the direction of governance and strategic autonomy.

Across the interviews and in the reflections obtained during the workshop various needs were expressed about the required physical transitions but also the behavioural and institutional arrangements that provide impetus to this. This comes with a need for a full understanding of the suite of options available to the national government, with insights on the regional endowments and alternative options to be considered. Several stakeholders indicated the need for a better grasp on ‘responsibilities’ and ‘power relations’ across (inter)national value chains, administrative layers and financial institutions. Specific emphasis was put on long-term perspective on favourable industries and trade/transport infrastructures. Underscored during the workshop was also the importance of the users of the production systems and how they provide incentive to their transitions (ranging from consumer behaviour to (normative) changes in socio-economic arrangements).

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Negative emissions [1]	S,T,A	long term >20 years	I
Integrating circular economy principles into the wider range of transition agendas [2]	S,T,A	short term < 10 years	N
Supply chain analysis and management: how much material is used and where it comes from, determining strategic reserves and sustainable value chains.[1]	S,T	short term < 10 years	N, E, I
Spatial claim for new activities (e.g. for circular economy) [2]	S	short term < 10 years	R, N
Flexibility of industry in light of infrastructural needs [1]	S	short term < 10 years	N
+ Financial and institutional arrangements [3]	*S*	*short term < 10 years*	*R, N, E*
+ Influence of actors in production systems [3]	*S*	*short term < 10 years*	*R, N, E, I*

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

11.1.3. Nature & environmentally friendly energy transition

For the theme ‘nature & environmentally friendly energy transition’ various innovation and environmental policy agendas are at play. Quite elaborate innovation programmes have been developed for both off-shore and on-shore energy oriented transitions under the auspices of MTIB, although nature and environmental issues are considered subordinate to other policy objectives (Kusters et al., 2023). Distinct marine and land-based knowledge and governance ecosystems are subsequently supported via sectoral policy departments (Kusters et al., 2023; Matthijsen et al., 2019; van Hoorn, in prep).

Across the interviews various knowledge needs were indicated about the optimal ‘design’ and ‘placement’ of renewable technologies (on land or at sea) and their ‘ecosystem impacts’. Simultaneously the tracking and integration of alternative policy challenges are subjects of discussion, such as ‘monitoring systems’ and ’value appraisal criteria’ for nature-positive development, but also circularity, etc. On the level of governance several questions were posed about (ministerial) ‘responsibilities’ around area-specific nature-positivity developments. Simultaneously questions have been raised around how such area-specific developments can be made profitable for private actors. A system to account for a ‘balanced consideration of interests’ and ‘different land-use options’ is also considered essential (also echoed in (van Oorschot et al., 2024)).

During the workshop it was articulated that physical implementation and impacts on a project level are important to study, but left in the hands of plenty of active knowledge and practice actors already. Added value is still to be found in the overarching view of the collective momentum and the cumulative & long term effects (e.g. on mortality, disruption and the risks for biodiversity, people). Embedding it into the nature-positive movement was suggested as a helpful step forward.

R&I Priorities – and why urgent and/or important? [experts]	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Maximum potential of nature value to be reached in land based renewable energy projects. Working towards emerging value appraisal criteria (rather than incremental project evaluation) [1]	S	short term < 10 years	R, N
What are the long-term impacts of (lack of) incentives? [1]	S	short term < 10 years	N
How can area development strategies for nature development be best fitted into renewable expansion (as complementary to project development)? Identification of potentially successful area development criteria, such as water management changes of large scale planning structure [1]	A	short term < 10 years	R, N
How can fragmented funds and the variety of authorities be aligned into a single framework? [1]	A	short term < 10 years	R, N
What role should the national government play in this theme? [1]	T	short term < 10 years	N
+ how can it be better embedded in the nature-positive movement?	*A*	*short term < 10 years*	*N, E, I*

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

11.1.4. Biodiversity and climate

Only limited integration exists of biodiversity considerations in climate policies, with international development and trade policy being the most explicit about it. In the former case it has been the advances in the United Nations conventions (e.g. UN Framework Convention on Climate Change, UNFCCC, and the UN Convention on Biological Diversity, CBD) pushing national agendas for integration (CBD, 2024; COP28, 2023). In the latter case transnational 'ecological footprints' and biodiversity loss have been metrics in policy developments (van Oorschot et al., 2024). Overall, the theme is mostly framed in the context of food production systems, climate adaptation and health in a national context, with sectoral policies and the Dutch research council supporting national actors on systemic knowledge development and experience (Verveld, 2024). European funding mechanisms drive knowledge development related to 'transformative valuation' or 'nature-based solutions' additionally (EC, 2024).

The interviews and reflections in the workshop indicated that there are many subtopics to be considered under both umbrella terms, but these are not necessarily addressed in connection to each other. Knowing the synergies and trade-offs of both policy domains, as well as the effects and risks of (parallel) policies packages, have been addressed as a first need. Another point that was emphasized during the workshop but less during the interviews, is the need for more administrative knowledge on how to move actors coherently in the right direction (Sustainable Finance Lab, 2022). Earlier studies (e.g. (Boezeman et al., 2024; van Oorschot et al., 2024) addressed this as a need for 'coordination', 'mainstreaming' and 'prioritisation' of nature and biodiversity considerations across administrative layers.

R&I Priorities – and why urgent and/or important? [experts]	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span **	On what level will this impact take place?***
Agriculture and food systems [1]	S	short term < 10 years	N
Climate adaptation [2]	S	long term >20 years	N
Ecological Footprint of the energy transition. Halving the ecological footprint [1]	S	long term >20 years	N
Plantbased and protein diet transition [1]	S	long term >20 years	N
Biodiversity restoration [1]	S	short term < 10 years	N, E, I
+ Synergies and trade-offs, risks and effects of the available portfolio of options [2]	*S*	*short term < 10 years*	*R, N, E, I*
+ Administrative and governance oriented knowledge [2]	*T*	*short term < 10 years*	*R, N, E, I*

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

11.1.5. Sustainable urbanisation

Sustainable urbanisation is a topic driven by many national and subnational agendas, with innovation and environmental policies imposing pressure on the public service requirements of urban space. The multiple incremental decisions made at various organisational tiers are key in understanding why particular zoning areas and permitting decisions are made. In the Dutch literature on this topic a growing concern on the coherency across policies is articulated (RLI, 2021). During the workshop it was stressed that sustainable urbanisation is generally approached from a one-dimensional view. Instead, it should be approached as a more integrative challenge. Focus should be given to building an understanding of the underlying factors for decision-making processes and a systemic development of a knowledge base.

R&I Priorities – and why urgent and/or important? [experts]*	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span **	On what level will this impact take place?***
How to make sustainable urbanisation economical and therefore prime choice? [1]	A	short term < 10 years	R
Knowledge around land take [1]	S	short term < 10 years	R, N
How can one utilize knowledge better in the domain of sustainable urbanisation? [1]	T	short term < 10 years	R, N, E, I
How can the different sustainability agendas be coupled [2]	A	short term < 10 years	R, N
What are the systems, processes and social dimensions in coordinating knowledge across tiers? [1]	A	short term < 10 years	R, N
+ what are the institutional systems for zoning and permitting	*S*	*short term < 10 years*	*N*

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

11.2 Promising funding schemes

The existing R&I planning in the Netherlands has taken on a more economic-engineering-centred project-based orientation. This favours ES R&I challenges to some extent that have technological transitions at their heart, such as 'resilient, net-zero and circular production systems' and 'nature & environmentally friendly energy transitions'. Many of the available governmental funds and funding agencies contribute to mission-oriented or curiosity driven knowledge development in this direction, albeit with varying political goals and directions in mind. Some public funds have had the potential to intersect on multiple domains, extend beyond short term needs and address more socially oriented challenges - the National Growth Fund has been specifically mentioned (with projects like NL2120 (NGF, 2024b), Material Independency & Circular Batteries (NGF, 2024a), Re-Ge-NL (NGF, 2024c) that run for 5-10 years) - though the fund has been discontinued in 2024 with uncertainties about running awarded projects to full term (WRR, 2024).

Thematic areas that have a more environmental or area development perspective, such as those related to nature and biodiversity (e.g. 'nature & environmentally friendly energy transitions' or 'biodiversity & climate'), or that require intrinsically (or immediate) political decision making due to competing interests or prioritisation needs are less prevalent in existing R&I programmes (e.g. 'sustainable urbanisation', and 'resilient, net-zero, circular production systems' to some extent). Sectoral policies on national and European levels may provide the impetus for research towards those specific directions. Funding schemes that have facilitated work in these directions have been more generic or occasional in nature and are therefore more unpredictable. More durable financing is provided via ear-marked budgets for public organisations. Clear examples of these are the activities of public research organisation that are (partly) covered by base funding (e.g. planning agencies, departmental knowledge institutes and national labs).

11.3 Improving the Science Practice Policy interface (SPPI)

The Netherlands has a fairly extensive knowledge infrastructure to inform policy with evidence-based information. These organizations mostly entail planning agencies, advisory councils, applied research institutes and a variety of consultants that are contracted to conduct ad-hoc studies. These are not necessarily also actors that structurally partake in activities in the dedicated R&I infrastructures. Science-practice activities are stimulated via funding agencies (e.g. Dutch Research Council, NWO, Dutch Enterprise Agency, RVO) and through co-financing from the private sector.

Crosscutting sustainability challenges are reverse engineered into existing R&I or policy programmes, creating friction between societal challenges (missions) and traditional goals like 'earning capacity'. Adoption and integration of newly arising sustainability challenges occur therefore slowly. Reasons for this are that crosscutting themes may be handled in parallel systems that are maintained by multiple policy directorates or across ministries. Various processes have been designed to stimulate greater integration, but these lean on the shoulders of motivated individuals. Similarly, crosscutting themes may be quickly overshadowed by competing interests or urgent matters with immediate (material) consequences for society (e.g. grid congestion). Politicized topics (e.g. security of supply, housing shortages) help to raise urgency of specific policy agendas, though research programmes and funding schemes may only be reactive after the fact. For other topics, institutional arrangements can be introduced to safeguard from a shift of attention, such as subsidies, certification systems, codes of conduct, and assessment frameworks that keep the sustainability challenge in mind (with examples found in the topic of nature-inclusivity).

Money appears not to be the main limiting factor. The department budgets are increasing yearly (Rijksoverheid, 2024), if one governmental fund ends appeals are made to another and competitive research opportunities are available in greater numbers than can be managed. Fragmentation and differences in governance or coordination across the board are therefore considered greater limiting factors for the capacity to act on crosscutting sustainability challenges. The operational needs remain tacit without specific problem ownership – particularly on needs related to (1) coordination, (2) mainstreaming, (3) prioritisation. This conclusion is broadly in line with a recent study conducted by JRC (JRC, in prep).

Themes that are closer to implementation and execution will have to account for the fact that context matters. Distinct differences exist in the application fields, such as in their accessibility and visibility. It is considered essential to include many relevant local stakeholders in the planning, implementation and monitoring phases. Subsequently, hands on facilities are missing that could facilitate communal learning (D&B, 2022), retention (Paradies et al., 2023), budgeting or collaboration (RLI, 2021). Although this is also true for the national level, it is particularly subnational administrative layers that face challenges in available capacities to coordinate and align.

11.4 Recommendations for CASRI by NKS

Knowledge needs to advance policy making and societal transitions in specific thematic areas are relayed in a variety of means. Deducting what is relevant for boundary organisations involved in advising national governments, we come to the following recommendations as provided in discussions during interviews and consolidation workshops.

Thematic recommendations

Resilient, net-zero, circular production systems: 'Resilient, net-zero, circular production systems' is a theme that is covered by, amongst others, innovation policy, environmental policy and security policy agendas. As a result there are various research drivers active in parallel with each their own objectives and participating ecosystems. Across the interviews needs have been expressed on both the physical required transitions but also the behavioural and institutional arrangements that provide impetus for this. Across a range of stakeholders a need was expressed for knowledge on the collective influence, responsibility and impact of (inter)national supply chains and the actors involved on obtaining (inter)national policy goals (which can range from e.g. demand shifts, influence of markets, (inter)national investment agendas, multinational behaviour).

Nature and Environmentally Friendly Energy Transition: The theme 'nature and environmentally friendly energy transitions' is mostly driven by implementation agendas. As a result practitioners (e.g. private actors, interest groups) are in the lead of mainstreaming the methods to account for nature-positivity. Given a lack of central coordination, there are inherent difficulties in keeping the bigger picture and the growing momentum in view and keeping track of cumulative and long-term impacts of specific applications. Understanding how nature-positivity is mainstreamed into the policy domains is considered key to moving forward.

Biodiversity and Climate: Only limited integration exists of biodiversity considerations in climate policies, with international development and trade policy being the most explicit about its integration. Knowing the synergies and trade-offs of both policy domains, as well as the effects and risks of (parallel) policies packages, have been addressed as a first need. Another point that has been underscored during the workshop but less during the interviews, is the need for more administrative knowledge on how to move actors coherently in the right direction

Sustainable Urbanisation: Sustainable urbanisation is a topic driven by many agendas, with innovation and environmental policies imposing pressure on the public service requirements of urban space. Instead it should be approached as a more integrative challenge, for which the multiple incremental decisions made at various organisational tiers are key in understanding why certain zoning areas are chosen or how permitting decisions are made. Structural attention is asked to both building understanding of these processes and a systematic development of a knowledge base on it. There is interest to develop better understanding of the different institutional systems around zoning and permitting and what arrangements are set in place to optimize this for people, planet and profit.

An international strategic research and innovation agenda that drives a collaborative effort across European countries could facilitate learning around best-practices in mainstreaming the integration of policy domains and comparing the institutional arrangements that excel or block transformative change. Leading expert communities can support the articulation of more detailed needs.

Process oriented recommendations

The thematic areas of study have indicated an accumulation of (knowledge) needs that relate back to the need for ‘coherence’, ‘alignment’, ‘coordination’, ‘mainstreaming’ and ‘prioritisation’ across the administrative layers and policy domains. Various suggestions therefore recommended that boundary organizations, like PBL, could help in identifying no-regret options, categorize and clarify existing (best-practice) examples, long-term perspectives and integrated analysis.

Actionable knowledge needs for implementation actors may not be the initial scope of attention for an organization like PBL. However, the collective result of all these activities, and keeping overview of its effectiveness, may be of interest. Indicated needs on that level therefore require reformulation to become a relevant question for a boundary agency like PBL.

Knowledge development for societal challenges requires long term commitment. The project-based orientation of existing R&I programmes was experienced as time consuming and not rewarding for the majority of the time, notwithstanding that boom-and-bust cycles are created with its characteristic consequences for producers and end users.

Given different funding constructions across public and private research actors, a lot of knowledge may already be available that has not been developed under the existing (public) R&I infrastructures. Scoping for these (academic) knowledge pockets and compiling a synthesis may be fruitful.

11.5 Reflection on the workflow

The CASRI workflow has presumed several assumptions of how a knowledge infrastructure is arranged and used in policy making. Several learnings can be deducted from the applied research process for the Dutch research context:

A better scope of study can lead to more actionable knowledge? The definition of actionable knowledge is interpreted to the boundaries of the science-policy interface in the context of PBL. Although knowledge needs beyond this scope can be observed and documented they are out of scope of action for (boundary) organisations like PBL.

Strategic research and innovation agendas drive knowledge development? Various stakeholders across the themes indicated that knowledge needs are initiated through bottom-up approaches, e.g. via interest groups that want to find a solution to an issue, not through central top-down coordination. Hence, although innovation policy has adopted a structure where (national) research agendas and innovation programmes are periodically co-created with a wide range of actors, they tend to only offer limited impetus for science and practice actors to engage with several sustainability themes.

Broad thematic knowledge coordinators exist? The selected themes as presented in this report are broad umbrella terms that cover multiple policy fields and knowledge ecosystems. Although knowledge coordinators may exist on specific strands or orientations an overarching view can only be acquired by systematically inquiring them all. As a result we touched base with more experts in the field than required throughout the CASRI project to gain a more comprehensive overview. However, still this can be considered a selective group that offers only a partial view. For this country report more emphasis has been placed on end-users and knowledge producers. The results are to be considered a mere snapshot of a limited set of insights.

Research orientations and needs can be tracked? This analysis makes use of public sources directly available for assessment, such as the project databases from the Dutch Research Council (NWO) and the European Union. This may provide a skewed view of activities that are mostly promoted through innovation policy drivers and instruments. An unknown number of activities is also commissioned through other public budgets (e.g. direct needs for sectoral ministries), public funds, or private budgets (e.g. consultancy work and R&D within bigger companies).

Crosscutting themes are not yet covered systematically? A variety of research agendas already exist, bearing a specific objective in mind. These may be single problem oriented. In the absence of a more detailed problem definition in the crosscutting themes, responses by stakeholders may only replicate more conventional outcomes, understandings, relationships and social networks (Norström et al., 2020). These availability biases are challenged only to limited extent in the current approach. It was recommended to utilize leading expert communities to help in articulating more specific needs.

The workflow results into a robust snapshot? Since completion of the interviews a new government has assumed power in the Netherlands with different political views than the prior one. The consequences of this are not accounted for in the current analysis.

12 SLOVAKIA – National Report

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Country report specific abbreviations

ESG	Environmental, Social, and Governance
MIRRI	Ministry of Investments, Regional Development and Informatization of the Slovak Republic
MoE	Ministry of Environment of the Slovak Republic
RES	renewable energy sources
SEA	Slovak Environment Agency
VAIA	Research and Innovation Authority

SUMMARY IN SLOVAK

Vo všeobecnosti možno konštatovať, že národní stakeholderi (NKS) na Slovensku vidia potrebu zlepšenia v oblasti výskumu a inovácií, čo potvrdzujú aj aktuálne národné strategické dokumenty pre túto oblasť. Oblasť výskumu a inovácií je na Slovensku dlhodobo podceňovaná a finančne poddimenzovaná, vrátane výskumu a inovácií v oblasti životného prostredia. Z dôvodu nedostatku príležitostí, mnohí talentovaní ľudia opúšťajú krajinu, doslova môžeme hovoriť o tzv. odlive mozgov do zahraničia. Zároveň aj Slovensko čelí bezprecedentným výzvam, krízam a podlieha megatrendom. Slovensko potrebuje inovovať svoj model ekonomického rastu podporou výskumu a inovácií a prístupom k ľudskému kapitálu. Tri kľúčové oblasti, v ktorých sú potrebné zmeny, sú investície do systému podpory výskumu, prilákanie a udržanie domácich a zahraničných talentov, a koncentrácia zdrojov na vybrané priority. V rámci uskutočneného národného prehľadu boli pokryté všetky témy projektu CASRI. Avšak domnievame sa, že na pokrytie potrieb a priorít výskumu a inovácií vo všetkých CASRI témach by bol potrebný širší časový rámec projektu. V prípade realizácie podobného národného prehľadu s rovnakým časovým rámcom a kapacitami by sme pravdepodobne urobili výber tém a pokryli len niektoré z nich. Rozhovory s NKS bolo náročné vtesnať do relatívne úzkeho časového rozmedzia. Avšak vítané by bolo zapojenie aj viacerých NKS. Hoci sme sa snažili osloviť NKS rovnomerne pre všetky CASRI témy, nie všetci reagovali na naše oslovenie, čo spôsobilo nerovnomerné zastúpenie NKS v jednotlivých témach. NKS, ktorí sa do projektu zapojili, boli nadšení pre spoluprácu v CASRI aj keď mierne skeptickí pokiaľ ide o budúcu implementáciu CASRI SRIA. Najviac zastúpenou témou medzi zúčastnenými NKS bola biodiverzita a klíma a odolné, uhlíkovo neutrálne a obehové produkčné systémy. Menej zastúpené boli témy udržateľnej urbanizácie a energetickej transformácie šetrnej k prírode a životnému prostrediu.Napriek tomu výsledky z národného prehľadu zachytávajú dôležité signály a impulzy pre príslušné oblasti.

NKS sa zhodujú na tom, že financovanie výskumu a inovácií je na Slovensku nedostatočné vo všetkých zmienených oblastiach. Nemáme jednotný rozpočet na výskum a inovácie a financovanie je roztrieštené. Pre účely financovania výskumu a inovácií a budovania výskumnej infraštruktúry na Slovensku NKS využívajú najmä Európske alebo medzinárodné zdroje financovania. Národné schémy financovania majú v porovnaní so schémami EÚ a medzinárodnými schémami malý rozpočet, a preto poskytujú menej príležitostí na kontinuálny špičkový výskum a vytváranie medzinárodných konzorcií.

Podľa názoru zúčastnených NKS, rozhranie vedy, politiky a praxe si na Slovensku vyžaduje takisto mnohé vylepšenia. Spolupráca medzi štátnymi orgánmi a vedeckou komunitou prebieha, ale podľa NKS nie je dostatočná. Chýba podstatne širší dialóg pri tvorbe politík a legislatívy. Zo strany štátu je potrebný väčší dopyt po vedeckých kapacitách verejných výskumných inštitúcií a ich zapojenie do týchto procesov. Zároveň je potrebné navýšenie kapacít a finančných prostriedkov pre tvorbu a riadenie vedeckej komunity, ktorá by ale vo svojom štatúte mala byť nezávislá od politiky. Nedostatočná je aj spolupráca s praxou čo má za následok slabú implementáciu strategických dokumentov a teda nedostatočné plnenie národných cieľov. Chýba komunikačná a organizačná štruktúra a takisto absentuje strategické plánovanie a podporné jednotky implementácie opatrení, ktoré by takýto proces mohli koordinovať. Mnohí NKS zdôraznili potrebu posilniť SPPI a implementáciu najmä na lokálnej úrovni, napr. tvorbou regionálnych a špecificky orientovaných sietí so zohľadnením loklálnych, resp. regionálnych špecifík a predností. Tiež je potrebné vytvoriť podporný legislatívny rámec v zmysle menšej administratívnej záťaže a napr. kratších povoľovacích procesov, a vytvoriť infraštruktúru pre vytvorenie lokálnej spolupráce s dlhodobou víziou.

Celkovo bol prístup projektu CASRI vítaný zo strany všetkých NKS. Bolo to pravdepodobne po prvýkrát, čo sa inštitúcia ako SAŽP priamo opýtala na potreby v oblasti výskumu a inovácií v oblastiach ich pôsobenia. Pre niektorých NKS to bola zároveň prvá spolupráca s SAŽP. Projekt CASRI zohral v kľúčovú úlohu nakoľko naštartoval veľmi potrebnú komunikáciu a vytvoril prepojenia s kľúčovými organizáciami a expertmi v príslušných oblastiach. NKS vnímajú CASRI ako príležitosť na posilnenie spolupráce aj na národnej úrovni, a hoci mnohí z nich boli zaneprázdnení, boli ochotní poskytnúť nám potrebné informácie a skúsenosti. O to viac je teraz našou úlohou zviditeľniť výsledky CASRI a pokúsiť sa ich implementovať. Národné hodnotenie však ukázalo aj nedostatky, pokiaľ ide o spoluprácu inštitúcií na národnej úrovni. Výsledky považujeme za dobrý základ pre posilnenie SPPI a celkovej spolupráce inštitúcií pre dosiahnutie udržateľného rozvoja. Udržateľnosť je centrálnym pilierom Agendy 2030 a Európskej zelenej dohody ako aj národného strategického dokumentu Slovensko 2030. Udržateľnosť je významnou témou, o ktorej je potrebné hovoriť stále viac. Výsledky projektu CASRI, ktoré priniesli rozhovory s NKS sú významným krokom Slovenska k udržateľnosti a postaveniu SAŽP ako orgánu, ktorý by danú transformáciu v zmienených oblastiach mohol koordinovať.

EXECUTIVE SUMMARY IN ENGLISH

In general, the NKS see the need for improvement in the field of R&I in Slovakia, which also confirms the current national strategic documents. Many talented people leave Slovakia because of insufficient opportunities to fulfil their potential. At the same time, we are facing unprecedented challenges, crises, and trends. Slovakia needs to innovate its growth model by supporting R&I in the area of environment, and its approach to human capital and therefore has a vision to increase the competitiveness of the economy and the quality of life by promoting R&I, and talent. Three key areas where changes are needed are investment in the research support system, retention of domestic and foreign talent, and concentration of resources on selected priorities.

During the national review we covered all CASRI topics, which was quite challenging. We feel that it would need a broader project time framework to cover the R&I needs of all important topics. Next time with the same time framework and capacities we would probably do the selection of the topics for national review. It was difficult to squeeze the interviews with NKS into a relatively narrow timeframe due to their busyness, but more engagement from individual NKS who did not participate in the interviews would have been welcomed. Although we tried to reach out to NKS equally for all topics, not all of them answered our invitation. Those who did were enthusiastic about collaborating at CASRI, although slightly sceptical about the future implementation of CASRI SRIA. The most represented themes among the participating NKS were biodiversity and climate and resilience, net zero and circular production systems. Fewer NKS covered sustainable urbanisation and nature & environmentally friendly energy transition. Nevertheless, the results of the national review capture important signals and impulses for the areas concerned.

All NKS agreed that R&I funding is insufficient in Slovakia. An unified budget for research is lacking, and funding is fragmented, so it is impossible to determine the real effect of investment in research and innovation, sufficiently. NKS more often uses the EU or international funding schemes for R&I than the national ones and tries to join international project consortia. The national funding schemes are small in the budget when compared with EU and international schemes and thus provide fewer opportunities for continuous cutting-edge research and the creation of international consortia.

According to NKS, we need to improve a lot when it comes to SPPI. There is cooperation between the state authorities and the science community but it would need considerably more dialogue in policy and legislative making processes. More demand for the science capacity of universities from the state and involvement in those processes is required. At the same time, it is necessary to increase the capacities and financial resources for creating and managing the scientific community, which, however, should be independent of politics in its status. Cooperation with practice is also weak, which results in poor implementation of strategic documents and thus not sufficient fulfilment of national goals, which raises significant concerns. There is a lack of communication and organisational structure, as well as a lack of strategic planning and support units for the implementation of measures that could coordinate such a process. Many NKS emphasised the need to strengthen SPPI and implementation in particular at the local level. There is also a need to create a supportive legislative framework in terms of less administrative burden and e.g. shorter permitting processes, and to create an infrastructure for the creation of the local cooperation with a long-term vision.

All in all, CASRI's approach was highly appreciated by NKS. It was probably the first time that an institution like the SAE had asked NKS about R&I needs in their areas of work and with some NKS It was the very first cooperation for SEA. The CASRI project played a key role in initiating much-needed communication and creating connections with key organizations and experts in relevant fields. They see CASRI as an opportunity to strengthen cooperation at the national level too and even though many of them were busy, they were willing to provide us with the necessary information and experience. It is now all the more our task to make the results of CASRI visible and actionable. However, the national review also showed that there are shortcomings in terms of the cooperation of institutions at the national level. We consider these results as a very promising base for the strengthening of SPPI and the overall cooperation of institutions in achieving national goals.

12.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

12.1.1. National research context

National sustainability policy is in full compliance with Slovakia's international commitments in the field of sustainable development in its economic, environmental, and social dimensions. In particular with the European Green Deal (EGD) which remains a key document at the EU level and builds on the 2030 Agenda for SDGs while responding to climate change. The national sustainability goals are based on six priorities approved by the government:

1. education as a basic prerequisite for a full and dignified life and to foster adaptability and a willingness to learn, as there is a high degree of uncertainty in the future scenarios to which it will be necessary to respond.

2. knowledge-based and environmentally sustainable economy in the face of demographic change and a changing global environment.

3. reducing poverty and social inclusion to decrease the number of people at risk of poverty and social exclusion.

4. sustainable settlements, regions and landscapes in the context of climate change to adapt to the impacts of climate change and cope with the deteriorating state of the environment.

5. The rule of law, democracy and security. After more than 30 years of independence of Slovakia, certain institutional and functional settings of the system of public authority must be evaluated and revised to reflect the basic constitutional principles of the rule of law, democracy, protection of human rights, pluralism, and participation.

6. Human health. Ensuring healthy lives and promoting well-being is a prerequisite for the sustainable development of society.

For each of the priorities there are several specific challenges identified to achieve the goals. They are further integrated into the three development programmes set out in the document The Vision and Strategy for the Development of Slovakia until 2030 (hereinafter referred to as “Slovakia 2030”) which is the basic implementing document for the national priorities of Agenda 2030. Slovakia 2030 itself generally sets the objectives to support the R&I towards national sustainability goals, and they are elaborated more specifically in others strategic documents. One of the most important is The Research and Innovation Strategy for Smart Specialisation of the Slovak Republic (RIS3).

RIS3 defines the main areas of applied research and innovation where Slovakia needs to focus the funding in the coming years. The National Strategy for Research, Development and Innovation (hereinafter referred to as “national strategy”) does not yet specify national research priorities but set the ambition to systematically collect and analyse data in order to set national research priorities and refine existing domains of specialisation.

One of the objectives of the national strategy is to increase coordination and simplify the complex system for managing R&I, which is currently fragmented among the ministries. It is managed by several organisations mainly under the remit of the Ministry of Education, Research, Development and Youth of the Slovak Republic and the Ministry of Economy of the Slovak Republic. Regarding the funding of R&I, there are other organisations and ministries involved (such as the Ministry of Investments, Regional Development and Informatization of the Slovak Republic). Then different R&I organisations conduct research as a core business or partially. Hand in hand with harmonisation of the R&I managing system the goal is to establish an inter-ministerial budget for R&I to allow predictable funding planning and more effective measurement of the impact of investments. The country’s core organisations regarding the R&I are the Slovak Academy of Sciences and the national universities. Both above-mentioned institutional bodies are funded by the state and out from that budget fund smaller R&I projects through basic and applied research. While most calls from the national authorities regarding funding of R&I are discontinuous or fall into a narrow field of focus with specified themes or problems, general opportunities are relatively narrow and do not fall within the concept of R&I needs to be generated by the public demand and priorities. The wider frame of opportunities is provided through European or international funding opportunities to which many institutions, and research teams could identify themselves with and conduct R&I driven by the real demands and priorities. This is mostly created by expertise-driven understanding of the current challenges in the respected fields.

The Slovak Environment Agency (SEA) is an institution with a national scope established by the Ministry of Environment of the Slovak Republic (MoE) in 1993. SEA supports the sustainable use of the environment and natural resources, its protection, and management by providing the knowledge to the government and the public. For CASRI purposes, we can classify SEA as a knowledge consumer/ end user and knowledge provider. Concerning R&I, SEA conducts activities mainly through the Department of Environmental Research (which is a part of the Division of Research and International Cooperation) and conceptualises its research activities based on the national and international cooperation with research institutions and universities. It deals with emerging issues regarding biological invasions and creates a conceptual framework for the geotopes management (including research) and foresight activities. In relation to CASRI, SEA’s Division of Research and International Cooperation is mostly created by researchers and holds respectful experiences and knowledge to meet with current and emerging environmental problems and to deal with them on the European level with other relevant institutions in the field of environmentalism and ecology. Regarding R&I, SEA lacks intellectual capacities and faces challenges in terms of expertise coverage of the relevant environmental fields, which hinders its development and cutting-edge research. Among the main achievements in relation to R&I is the hold of the Certificate of Competence to Conduct Research and Development, provided to SEA by the Ministry of Education, Research, Development and Youth of the Slovak Republic, based on the achieved research results and research project acquisition.

Other branches such as the Department of Environmental Upbringing, Education and Edification focus on providing knowledge to education institutions such as high schools, and promote environmentally relevant issues. The Section of the Recovery Plan on the other hand serves as a board for implementing the National Recovery Plan of the Slovak Republic by providing services in relation to restoring homes in the country to meet the current demands regarding energy efficiency etc.

The CASRI SRIA can bring us an opportunity to enhance the strategic research development in Slovakia, break down the barriers, and work across ministries and sectors, with the aim to handle the emerging issues that the environment is challenged with. It could help us build a stronger partnership between the state and the scientists and guide the R&I in achieving the national sustainability goals. It could also connect our scientists and experts throughout various fields with the partners at the EU level which is key as Slovakia has a limited and fragmented research capital and underdeveloped visions. SRIA could be a valuable source of information for the government but also for public research institutions that are directly handed from relevant stakeholders for strengthening the real implementation, which is what we really need to focus on in the coming period both at the national and EU level. Additionally, SRIA by addressing the real R&I needs and priorities can encourage the involvement of the private sector in the R&I funding and multiply the amount of finance needed to support transition towards sustainability.

The added value of CASRI is creating new partnerships and communication channels in order to create a strong voice for the transition to a greener future by supporting the EGD. Focus on the EPAs and their agenda on the national level elevates the status of the EPAs and gives them the initiative back to lead the way and embrace their agendas. Much needed is the multi-sector oriented policy creation in order to support sustainability and to find ways of enhancing the implementation by achieving synergies. There is a necessary prerequisite for fulfilling the R&I needs and priorities, and that is overall support for the R&I using increasing funding and capacity building. This is crucial to addressing the identified R&I needs and priorities and starting to create a demonstrator to showcase the stands and present the working mechanism behind them.

Exploiting international and European funding opportunities and creating new novel mechanisms for financing these important needs and priorities opens up many new possibilities of interest to the Slovak Republic and SEA. In this regard, actionable knowledge is of pivotal importance along with the strong support of the EGD implementation oriented policy of the leading parties. The key and much needed elements for Slovakia could also be achieved thankfully to SRIA by presenting much needed communication tools in terms of positive lobbying and dissemination of the agenda.

12.1.2. Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Circular materials: substitutes for primary natural resources, especially renewable local resources, and their applicability in the circular economy.	A	Energy independence, and low- or zero-emission local energy systems contribute to the sustainability of public and personal finances through cost optimization and cost efficiency. In the context of a country's competitiveness as a location for investors, green renewable energy is a crucial criterion for many investors. In the context of competitiveness of supply chains - in recent years sustainability has become an equal selection criterion alongside quality and price. In the context of ESG reporting, where the whole value chain is taken into account, the topic of renewable energy sources (RES) is gaining importance. Positive shaping of public opinion towards renewables due to the improved availability, efficiency and attractiveness of local RES (price, investment costs, technical and technological complexity). Short and long term effects.	N/I
Waste recovery.	T	Exploitation of the energy potential of waste, and reduction of emissions from waste treatment (landfilling as a significant source of methane), is a necessity due to the lack of capacity in Slovakia, which also affects competitiveness.	R/N/E/I

		Waste management and recovery options are of interest to every current and potential investor. Short and long term effects.	
Development of integrated indicators for sustainability when assessing CE effects.	T	Effectively set environmental policies. Integrated indicators reflect whether an activity is sustainable or not. Such indicators could help when setting or adjusting the environmental policies and enable the prioritization of measures. Short term	I
In-depth research on changes in groundwater quality and quantity due to the multiplicative effects of environmental factors such as climate change, pollution etc.	T	A question of human health, ecosystem health, and global security issues (potential war conflicts due to lack of water resources in the future). Short term	R/N/E/I
Battery backup systems.	A	1st Short-term effect: a supporting tool for the development of RES in terms of grid stability and the prevention of fluctuations. In the private business sector, there are already the first examples of combining RES installation and battery storage in Slovakia. Such a combined system is also growing in households. This is an important tool also from the point of view that the insufficient capacity of the network is a real obstacle to connecting to the network and thus putting new RES into operation. 2nd Short-term effect: the natural development of RES, allowing time for the gradual increase of capacity and the overall development of the distribution network, as well as the natural pressure on this development. Long-term effect: Contribution to achieving climate neutrality.	R/N/E/I

Analysis of products relevant to the production of social enterprises.	A	Use of local production potential while achieving a positive social impact at the local level. Supporting disadvantaged populations by providing new job opportunities. Short term.	N
Integrate R-strategies products into an innovative approach to education at all levels. (R-strategies: the R-strategies, sometimes also referred to as the R-Hierarchy or the R-Ladder, fall under a hierarchy. It is a useful tool for visualising and understanding the different stages of resource use and waste management in a circular economy.	T	Short-term and then long-term effect Elements of social innovation for the general public through education, inspiring a change in attitudes or attitudes leading to a change in public behaviour towards more environmentally aware and responsible communities. To achieve the common goal of sustainable living in a healthy environment learning to work together, helping each other with the approach of the quintuple helix innovation model creates a liveable environment for residents who, in collaboration between public administration and local government, educational organizations and businesses, gain socially just jobs. This model of innovation is based on knowledge sharing in a framework of shared response.	R/N/E/I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

12.1.2. Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Modelling and evaluating the effects of climate change on the Ecosystems (complex and holistic approach).	A	There is a lack of foresight on the impact of climate change on different types of ecosystems.	N

		These activities could improve national environmental policies and help prioritise actions, particularly in sectors where the impact of climate change may not be obvious at first sight. Short term with long term implications for the management and further evaluations.	
Applied research on different ways of managing natural and semi-natural ecosystems to secure a wide range of ecosystem services.	A	Supporting the functionality of ecosystem services of various types of ecosystems, especially forests. We have relatively sufficient data for maximising the wood production function of forests. But we lack data on how to manage forests if we want to support other ecosystem services of forests, e.g. water retention, and carbon sequestration. Ideally, forest management that enhances the delivery of all forest ecosystem services. Applied research on forest management practices, even if we anticipate positive impacts in advance and consider all potential impacts for other sectors for example biodiversity. Short term research priority but with desirable long term follow up, due to long life spans of the forest ecosystems and some actions that require long exposure in order to take actions	R/N/E/I
R&I in climate change adaptation, in particular the possibilities of obtaining (accessing) information/images from satellites, e.g. on heat waves at the local level.	A	There is a lack of adaptation measures, especially at the local level due to insufficient data and evaluation tools. Availability of data will enable Slovakia to better adapt to climate change, and prepare effective local adaptation strategies. Short term	R/N

Ecosystem accounting.	T	The contributions of ecosystems to society expressed in monetary terms can provide information for decision-makers, for example for economic policy planning, cost-benefit analysis, and for raising awareness of the importance of nature to society. Short term	R/N/E/I
Evaluation of the ecosystems through remote sensing.	A	Protection of biodiversity through evaluating the dynamics of the ecosystem through time and space. Long term.	R/N/E/I
Landscape revitalization.	A	Immediate reduction of erosion, water retention in the landscape, and greening. Long-term effect: increasing the resilience of the landscape to climate change, biodiversity loss, by supporting the adaptability of the landscape as a whole system. Short term.	R/N/E/I
Ecological connectivity in particular research on migration corridors.	A	Protection of biodiversity in fragmented areas by creating efficient bio corridors and reducing the mortality rates of living animals. Short term with a need of follow up and re-evaluation due to possibilities of dynamically changing environment in the agriculture.	N/E
DNA analysis in biodiversity assessments.	A	Improvements in detecting the abundance and population status of species in particular ecosystems. Short term.	N/E
Management of biological invasions.	A	Invasive species pose a serious risk to biodiversity by facilitating biological invasions, which are characterised with serious negative effects in terms of endangering the local and often endemic species. Management of different species poses new challenges and for many of them there are no efficient means of control. Short term.	N/E

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

12.1.3. Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Contribution to achieving EU's energy and climate goals and make Europe a global leader in clean energy and energy efficiency technologies.	A	Supporting the development of new cutting-edge technology for sustainability measures in the energy sector through energy efficient and smart technologies used in urban planning and construction of smart cities including buildings, communities and positive energy districts. Long term.	R/N/E/I
Addressing mobility issues and developing novel and intelligent means for the infrastructure as well as the vehicles.	S	Making infrastructure workable to reduce the waste of energy and create a safe and clean environment through shifting away from fossil fuels. Improvements in this area would have positive cascading effects in other areas. Short term	R/N/E/I
Green infrastructure - research on integrated technical solutions, environmental as well as social aspects of solutions for economic sustainability including spatial planning and removing sectoralism.	A	Short-term effect. Contribution of measurable indicators to the function values of the proposed green infrastructure elements. Long-term effect. Elimination of long-term adverse impacts of climate change in terms of the environmental assessment of the environmental impacts of development proposals under the Taxonomy for the Environment. Increased strategic planning incorporating newest available knowledge.	R/N/E/I
Sustainable water management in the urban environment (drinking, precipitation, wastewater). Capture, retention, use. (e.g. use of rainwater from industrial sites).	A	Creating a more sustainable urban environment through novel proposals of management of addressed issues. Developing new sustainable and cost-efficient new methods for the prevention of extreme weather events. Short term	R

Building modern technical infrastructure for residential zones.	A	Rational urban and landscape planning and building infrastructure in densely inhabited areas. Long term	R
Greening of buildings, establishment of green roofs, green steins, innovative green solutions and their implementation in practice.	A	Implementing green infrastructure in cities. Bringing more greenery into building structures while focusing on novel methods, its development and utilisation of new renewable materials. Short term	R

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

12.1.4. Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?*	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Innovation in construction. Low carbon materials and greening of buildings.	A/S	Increase the energy efficiency of buildings and reduce energy costs. Long-term energy savings and CO_2 emission reductions, improving living comfort. Short term	R/N/E/I
Energy-saving buildings: material, work environment, building, outdoor environment.	A	One of the sectors that consume the highest amount of energy is the building sector. Increase the energy efficiency of buildings and reduce energy costs. Long-term energy savings and CO_2 emission reductions, improving living comfort. Short term	R/N/E/I
Gaining knowledge on agro-photovoltaics and its utility in praxis.	S	Agri-Photovoltaics consists in the simultaneous use of land for both solar photovoltaic power generation and agricultural production.	R/N/E/I

		It is highly relevant to a range of policies, including those related to the energy transition, agriculture, environment, and R&I, and directly supports the goals of the EGD. Short term	
Geothermal energy research and utilisation.	A	Geothermal power has huge potential as a clean energy source, even possibly becoming as important as fossil fuels are today, but not without new technologies to make the resource economically viable and available to all. Long term	E/I
To explore the potential of regions in terms of its local resource use.	A	Promotion of regional circular economy, self-sufficiency, and competition of the ability of regions/municipalities, etc. Short term	R/N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

14.1.5. Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?*	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Social-behavioural research.	T	Perception of the environment not only conditions people's passive attitudes towards the environment, but also strongly influences the active process of decision-making and behaviour in the environment. An individual's values, needs, impressions and opinions are often reflected in their spatial behaviour. Understanding the behaviour of specific groups of people towards the environment can help us introduce targeted measures to improve their perception of the environment and thus their willingness to behave more sustainably. Short term	R/N

Creating effective ways of raising public awareness of environmental issues in general.	S	The public may not understand environmental problems sufficiently, so they naturally reject measures, and restrictions leading to improvement of the environment. Raising awareness of environmental problems can increase acceptance of measures, and potential restrictions and motivate the public to help meet environmental objectives and support research and innovation. Short term	R/N/E/I
Cross-sectionality in research. The topics developed in one area of research need to be extended to other areas of research.	S	Exploring the effects of measures in one area to other different areas. Finding possible synergies and complementarities but also antagonistic effects and disagreements. Short term	R/N/E/I
Multiplicative effects of environmental factors on ecosystems and health (combinations of which factors may be the most critical for ecosystems and health).	T	Evaluation of singular and multipolar effects on various aspects of ecosystems and health. Tackling emerging problems and possible new emerging diseases. Long term	R/N/E/I
The links between the environment and global peace.	T	Evaluating effects of migration due to emerging issues such as the lack of quality and quantity of drinking water, heat, and climate change. To demonstrate the overlap of environmental problems with global policy and how they can be an issue in international conflicts. Addressing environmental security in the long term with emphasis on threats to the stability of states and communities, etc.	I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

12.2 Promising funding schemes

Slovak NKS relies mostly, like other organisations in the country, on European or international funds. The main funding schemes used come from the European Union, the European Just Transition Fund, and European Structural and Investments Fund. While the first barrage covers a broad area and doesn't focus primarily on research and innovation, the second group of funds, represented by Horizon Europe and Life, makes a primary source for funding research and innovation in Slovakia. Noteworthy is also a wide utilisation of national funds provided through the Slovak Research and Development Agency and the Ministry of Education, Research, Development, and Youth of the Slovak Republic. These funds are not major but are largely utilised by the NKS and other public research institutions in the country. Some other funds such as INTERREG are used less frequently due to co-funding. The preferred way of funding for the Slovak NKS is through non-refundable financial contributions and without co-funding.

Areas that are not sufficiently covered by the current funding opportunities are largely a result of the degree of awareness of the funding possibilities of the respected NKS. Areas such as 1. research and innovation in the technological processes and methods in the industry including decarbonisation, 2. protection of the environment including adaptation, mitigation measures and restoration, 3. research on circular materials (such as textile) including natural resources substitutes, 4. systemic solution for the transition to a circular economy with the emphasis on the societal economy, 5. hydrogen technologies, 6. revitalisation of brownfields and areas with environmental weight, and 7. research in forestry and rural landscape.

NKS in Slovakia have not suggested to their knowledge any new promising funding scheme for CASRI. But in the case of creating a new financial scheme, NKS recommends considering the priorities of Europe's survival as a whole, survival in terms of health and healthy ecosystems, in terms of food self-sufficiency, in terms of competitiveness in global markets. Very important is to set up appropriate time frames for projects, with more flexibility and the possibility of adequate changes within the project implementation if required and realistic criteria in terms of national processes (e. g. legislative/administrative conditions). The insurance sector is not responsive enough to climate change perhaps it should be more proactive, e.g. as a financial instrument.

Makes funding schemes as simple as possible with clear measures and expectations, and provides sufficient time for preparation of project proposal. It is necessary to ask for the real needs of private companies and build up demand-driven research project calls. Include relevant external experts, researchers, businesses, and also people from regional or local government. The funding schemes should allow taking into account the already implemented measures (e.g. regarding decarbonization).

To convince national funders to participate in a cross-national funding scheme such as the one CASRI is aiming to set up, many suggestions was presented in the NKS interviews and in the national workshop. All the stakeholders feel that there is an insufficient interest from the part of national funders especially private sector. First of all, continuous awareness raising about the importance of research is absolutely crucial. To attract the national funders we need to make our research visible and understandable to them, and not only the importance of concrete results/data but also its further use in achieving national environmental goals. We can use the annual reports of research organizations, forums (not scientific) where ongoing research will be presented, media presentations, nomination competitions, etc.).

The use of foresight studies could help to illustrate the potential future of Europe (scenarios for different sectors including banking and insurance) without the far-reaching societal change and the key role of targeted R&I in the implementation of measures towards sustainability to avoid the most critical scenarios.

It is important to ask about potential funders' real needs. In particular, for the private sector, we should be able to make a tailor-made offer - a “product” that is usable for them and backed up by data, previous analyses, etc. We should be able to demonstrate the quality of our work and the potential of specific research.

We have to motivate the national funders to be willing to fund R&I activities and optionally also become participatory. They will obviously ask about the benefits, financial and non-financial. Their investments should generate capital benefits in the future – more efficient production, use of the latest innovative materials, and increased competitiveness. Among the non-financial benefits, we can communicate building the reputation of the company and social recognition for supporting R&I and contributing to the sustainability goals (e.g. through public media, a kind of "green logo"). Also, an economic responsibility for one's own business/activity under the impact of an environmental crisis is important. Contribution to sustainable development provides a prerequisite for the survival of one's own business. The inaction to the environmental crisis is not a solution anymore. From the level of state, we could think about the favourable tax burden for national funders of R&I.

12.3 Improving the Science Practice Policy interface (SPPI)

There is a common consensus among the NKS about the need to improve the SPPI in Slovakia. Relations and communication between state institutions are relatively weak and systemic solutions to improve it are lacking, which remain a main obstacle.

Several NKS said that the interactions between the institutions are often based on personal contacts, which have no real or effective spillover into practice and politics at all. Data sharing is quite an important issue in Slovakia. Even state institutions' data are not automatically shared between them. Occasional solutions to minor practical problems have the character of Ad hoc actions.

Many NKS actively get involved in consulting processes on legislative proposals/strategic documents through the inter-ministerial comment procedure or strategic document evaluation. Some NKS (and other institutions) participate in policy-making processes through advisory bodies, working groups, memoranda of cooperation, etc. However, according to NKS there is a general lack of dialogue and insufficient involvement of important stakeholders in these processes. Especially, insufficient interaction and avoiding including universities into the processes (insufficient state willingness to involve universities). On the contrary, there is regular cooperation between NGOs and the academic sector. Currently, some legislative proposals are approved quickly without adequate consultation processes.

The policy sets the general frameworks, but implementation is lacking in the area of SPPI. Practice is blocked by administrative and legislative burden (excessively long authorisation processes that block the delivery of EU-funded project objectives) and thus naturally rejects "novelty" or rejects even an attempt at an innovative solution.

To improve SPPI it would need sustainable financing of research activities and innovation. Currently, resources in the R&I area are fragmented, non-transparent and it is not possible to evaluate the effectiveness and adequacy of the R&I budget in comparison European or international means of financing, that could be more specifically designed and well organized in order to cover this important theme. The aim is therefore to make the R&I budget more transparent and available in order to create a base for strategic planning and investments. General lack of funding and thus less opportunities for effective SPPI consortia is also identified as a key issue. As we have mentioned above, there is a lack of topic oriented discussion and specific talks from the state authorities in the policy-making process and it is necessary to strengthen cooperation between researchers, authorities, and practitioners to make policy making, planning and development more scientific based while utilizing the current knowledge and derived needs in Slovakia. The unbiased and politically free involvement of universities in state decision-making should be reinforced. On the one hand, there should be state demand for targeted research activities and actionable knowledge and, on the other hand, state support for conducting R&I (funding, capacity building, transfer of knowledge to praxis, sharing best practice, etc.). State authorities should strongly support cross-sector cooperation (creating cross-sector teams of experts), data, and knowledge sharing through open and innovative digital solutions.

In Slovakia, there is a problem with research capacities - the ageing of experts and the "brain drain" abroad. Being a small country with limited research capacities, it is essential for Slovakia to be involved in international research and international teams in order to conduct research and innovation, share knowledge and equipment and present examples of good practice.

Investment in the implementation of environmental policies at the local level needs to be supported and reviewed on the expert level. We have many strategic documents that are too vague and are not sufficiently implemented due to lack of proper analysis, synthesis of information and understanding of the topic. Regional and local strategic documents with concrete measures are required but should not be conducted without a systematic approach and evaluation in cooperation with regional or national experts such as SEA or self-governing regions. Slovakia has a negative experience in strategic document creation from the side of consulting agencies, that lack in quality, expertise, and actionability and thus are unusable for the implementation procedures. It is essential to encourage a participatory process when designing them, involving experts, local people on the ground, and also “ordinary people”. One of the options on how to strengthen the involvement of local people could be the creation of municipality associations, environmental centres, or consortia at local level. It may be challenging but effective in the governance of local implementation or applying for project funding in emerging issues such as adaptation to climate change or community and sustainability building.

Applying quadruple helix and quintuple helix innovation models were suggested by NKS. It is a form of collaboration in research and development between the four major sectors of society: industry, government, research institutions, and the public, that provide extra problem-solving capacity. The quintuple helix model further incorporates the natural environment into the helix. It views the natural environments, society and the economy as drivers for knowledge production and innovation, thus defining opportunities for the knowledge society and knowledge economy.

The R&I should be politically independent, serve a common social issue and be overall good for the society and the environment. In other words, Slovakia should invest in research and innovation in the field of the environment (but also elsewhere), regardless of the political situation, and set it up as a basic matter of priority interest. Setting up sustainable development of society as a whole has become not a part of the debate whether to conduct it or not, but in the light of current evidence, it has become an issue on how to implement it.

12.4 Recommendations for CASRI by NKS

One of the important notes raised by the NKS is the agricultural sector. It was identified as a key theme covering mainly biodiversity and climate but also referring to other fields discussed in CASRI. One of the main issues regarding the agricultural sector but also in relation to urban planning, energetics or nature conservation is the need for land reform and to solve the issues of scattered land ownership. Reforms in this area would open up possibilities for strategic planning and help implement measures for building up the green and blue infrastructure including nature based solutions to answer the pending environmental, societal and health needs.

Another key issue identified by the NKS is the need for a new framework and the way of thinking, managing and a need to stair away from sectioning and create new multilateral collaborations. A sectorial-oriented view is failing to achieve its undertaking and a proactive and interdisciplinary approach is very needed. Limitations to sectoral views of things have created an isolation of each of the branches and lost the vitally needed interconnections that different fields naturally have. To build up these connections, for example by creating new thematically oriented consortia and platforms is a much needed reform in Slovakia.

A need of a guide was identified as a major need in order to introduce knowledge into praxis and to conduct the transition of the idea into its realisation and to mediate the much needed communication of the different fields of the business. Both sides are dependent on each other and this shift into action (actionable knowledge) is a key stimulus for the sustainability transition that SEA could promote.

To have a workable system, there is a need for identification of the needs in relation to products identified and requested by the public demand and to create solutions and alternative scenarios for each of them in order to identify details of each of the demands and to communicate the results back. This participatory and also inclusive approach would achieve a better involvement of the public and the business into a cooperating and unified mechanism of action towards collective engagement and responsibility. To create and open up possibilities and present solutions alternative strategies and approaches are needed in every single field and theme.

Forests have a vast area of coverage on the surface of the earth, it has the power to create and affect the climate. In the light of changing climate and increasing demands towards forestry an increase in basic but also applied research is suggested in this field by the NKS. Terms of management and alternative methods of management of forest ecosystems are still pivotal in shaping the ways of forest management nowadays in the changing climate and the societal, economic, and political environment. The urban environment as a major element of public space needs to implement current knowledge in the green and blue infrastructure planning and thinking of biodiversity, its dynamics and the threats posed by the invasive species.

Creating migration maps could be of benefit to nature biodiversity and the public in the urban environment. Urban environment is facing new challenges and novel means are needed including research and innovation in this field.

It is also important for the implementation of the SRIA to fuse some of the priorities to create a larger and multilateral ones, and to create tools on how to fuse them and find the commons in order to address this multidisciplinary approach. To implement SMART technologies could help in collecting the much needed data along with the software analytics and evaluation processes to provide the results. One of the remaining challenges also concerns the energy transition and creating energy-efficient buildings incorporating novel materials that pose no harm to the environment, pose no additional pressure on the resources demand and still promote high quality. The same applies to industrial management of materials including circular economy and also it applies to sustainable mobility.

Creating energy efficiency and sustainability in terms of utilising renewables such as geothermal energy poses novel opportunities in terms of R&I, by creating new means on how to efficiently utilise it under different conditions and purposes. Technological aspects on how to boost the energy efficiency production systems is a demanding field of innovations. This could mean creating SMART cities and villages and also in creating biorefineries cross-sectioning the circular economy and also energetics.

12.5 Reflection on the workflow

CASRI was overall well accepted and all of the interviewed NKS welcomed and praised the focus and the approach. During the process of NKS selection, we tried to cover the recommended three categories (research and innovation funders, knowledge providers, and knowledge users), and all four main CASRI themes. However, not all selected NKS have responded to our invitation to be a part of the CASRI co-design process. On the other hand the ambitious number of 45 selected NKS was too high to process in the current NC setup. The information collated in this report is reliable and representative enough, but we would not say it is complete. The CASRI themes are comprehensive and it would need more than 20 NKS to find out and agree on all national R&I priorities for the environment. For example, some NKS pointed out at the workshop that agriculture seems and that it should be included in the CASRI topics.

Although we selected NKS to fit specifically to one or the other CASRI theme, many NKS were able to reflect on various topics and demonstrate the potential to broaden the overall national picture of R&I needs in the environment. It demonstrates the intersectionality of the NKS and also reflects the ever stronger necessity to work across sectors.

Through interviews and a workshop, we received a lot of input on R&I needs. Some of them were not explicitly R&I needs but general topics that need to be addressed. It was necessary to either reformulate them as R&I needs or remove them. After the revision of the Interim Results Report, we cluster and more specify the national R&I needs. In the national workshop, we made the prioritisation and discussed the identified R&I needs to make them concrete and clear enough. Regarding the SPPI, we tried to distinguish very specific national issues that need to be addressed rather at the national level and those, we believe could be addressed in SRIA.

Desk study of the most up-to-date strategic documents confirmed the overall perception of the situation concerning R&I in Slovakia. R&I needs are usually not exhaustively mentioned in sectoral strategic documents but there is an objective to support research in general in all of them.

Assuming we had more time (if the timeframe of CASRI would allow it), we would interview more than 20 NKS. We would also consider interviewing more than one person per organisation, which is useful when the organisation has more differently focused departments. Potentially, we would think about whether to cover all CASRI themes or choose only two or three of them. We had a very fruitful national workshop even though only 11 NKS participated. In order to increase participation we would plan the workshop more in advance (we set the date for the workshop 4 weeks in advance), and instead of a half-day workshop make at least a whole-day workshop, to have more time for more rounds of discussions.

13 SWITZERLAND – National Report

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Country report specific abbreviations

Eawag	Swiss Federal Institute of Aquatic Science and Technology
Empa	Swiss Federal Laboratories for Materials Science and Technology
EPFL	Swiss Federal Institute of Technology Lausanne
ERC	European Research Council
ERI	Education, Research, and Innovation
ETH	Swiss Federal Institutes of Technology
Innosuisse	Swiss Innovation Agency
NRPs	National Research Programmes
RIPA	Federal Act on the Promotion of Research and Innovation
SCNAT	Swiss Academy of Sciences
SERI	State Secretariat for Education, Research and Innovation
SNSF	Swiss National Science Foundation
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research

EXECUTIVE SUMMARY IN ENGLISH

In Switzerland, National Key Stakeholders (NKS) attribute different degrees of importance to research agendas and strategies. Academic institutions generally prioritize academic freedom over strict adherence to predefined research agendas. Among the five representatives from research institutions interviewed, none highlighted a specific research agenda as being particularly relevant to their institution. Rather, international policy initiatives and strategies – especially those at the European Union level such as the Green Deal – serve as guidelines to assess the overall direction and provide inspiration for the design of institutional research programmes and educational agenda setting. While funding programmes, strategies and agendas often cover specific topics, sustainability research also bears the responsibility to contextualize itself with respect to the overall sustainable development concept, look beyond set agendas such as the 2030 Agenda and more strongly anticipate future developments. Consequently, for many of our NKS, most ES R&I agendas serve rather as sources of inspiration than as rigid systems of constraints and gaps.

The analysis of ES R&I strategies, agendas, and funding schemes reveals that despite comprehensive thematic coverage, the need to better understand and be able to support transformative processes is not appropriately considered. The majority of NKS - 19 out of 21 – who emphasized this also stressed that sustainability challenges are not purely technical, but inherently

cross-cutting and deeply intertwined with societal realities, contextual dynamics, and legal frameworks.

Consequently, a broader perspective on research and innovation is required that includes social sciences, humanities and environmental law. These are often underrepresented in current ES R&I agendas and funding schemes.

Within the CASRI thematic areas, the following R&I priorities were expressed by NKS:

Resilient, net-zero, circular production systems: social Innovation for resource-light economies; equitable structural change; economic and financial systems; fair and inclusive value chains

Biodiversity and climate: ecosystem regeneration; understanding the balance between prevention and resilience of climate disasters; implication of climate metrics and indicators

Sustainable urbanisation: sustainability oriented spatial development and urban transition; urban-rural disparities

Nature and environment friendly energy transition: social aspects of a sustainable energy transition; optimizing energy production and regional planning of energy systems; sustainable energy mix

The following crosscutting R&I themes were expressed by NKS as urgent or important: societal transformation processes and just transition; democracy and participation; environmental policy, law and governance; health and wellbeing; agrarian transitions for sustainable food systems; geopolitical conflicts

NKS mentioned that current funding schemes are often compartmentalized, focusing on specific issues or themes without covering the broader scope of sustainable development, and creating significant gaps in the continuity of ES R&I projects. One significant issue highlighted is the missed opportunity of strategically aligning various funding instruments. Since another key issue are overlapping focus areas of different funding schemes, improved coordination is required to address both underfunded themes and redundancies to streamline efforts effectively. According to most NKS, funding instruments must better support transformative research – i.e. research that is part of societal change processes – by encouraging unconventional forms of scientific collaboration, experimentation and output. This is important because different fields of expertise are needed to work on complex sustainability problems. The key priorities centre on two fundamental aspects: the need for more systemic thinking, as traditional sectoral approaches fall short in understanding and facilitating necessary transformations, and the crucial integration of social science perspectives from the outset to ensure a comprehensive understanding of sustainable development. Funding schemes based on traditional academic structures may not adequately support the unique requirements and extended timelines of transdisciplinary research. The practical challenges associated with transdisciplinary research are significant, as it includes interdisciplinarity, requires extensive efforts to develop mutual understanding and effective modes of cooperation between different scientific disciplines, each with its own culture and methodologies. Strengthening the procedures and building capacities for evaluating interdisciplinary and transdisciplinary research proposals is equally important.

Related to this, NKS stated that given that Science Policy Practice Interaction (SPPI) involves collaborations with non-academic stakeholders, it is critical to provide a framework for incentivising

the onboarding of partners from the private sector and civil society including financial support from the very beginning of a research project.

The interaction between science, policy, and practice in Switzerland is characterized by a multitude of activities of federal agencies, academic institutions, and specialized intermediary organizations serve as primary actors, supporting evidence-based decision-making through well-coordinated knowledge exchange and stakeholder engagement. However, several NKS point out that current academic incentive structures still place too much of a one-sided focus on academic publications as the primary criterion and often undermines the recognition and reward of collaborative and problem-oriented research contributions. Addressing this issue is also critical to fostering an environment where SPPI can thrive. NKS stated that to strengthen SPPI, long-term projects that build trust with stakeholders and align ambitions with practical capacities are crucial. Collaboration across different fields of expertise and clear communication mechanisms are also key to bridging the gap between research results and practice needs and policy relevance.

Strengthening following spheres of SPPI was recommended by the NKS:

- Interdisciplinary and cross-sectoral collaboration
- Science-practice-policy exchange mechanisms
- Funding mechanisms
- Capacity building

13.1 Reviewed, synthesized and prioritized ES R&I needs and gaps

13.1.1. National research context

Sustainable development and its promotion by the federal government is a constitutional mandate in Switzerland (Articles 2, 54, and 73 of the Federal Constitution). In the education, research and innovation (ERI) policy sector, this commitment is legally reflected in the framing Federal Act on the Promotion of Research and Innovation (RIPA), which requires research bodies to consider the objectives of sustainable development in society, economy, and environment when fulfilling their tasks.

Thus, sustainable development is an important cross-cutting theme to be anchored and advanced in the federal ERI funding policy. The State Secretariat for Education, Research and Innovation (SERI) plays a central coordinating role in Switzerland's research policy. The SERI regulates research promotion at the federal level, elaborates the overarching R&I funding strategy and defines priorities and high-level participation of Switzerland in international programmes. SERI also monitors the performance and impact of the Swiss research landscape and ensure its competitiveness at the international level. As the primary hub for federal research activities, the SERI serves to guide national research efforts towards broader governmental priorities and strategies of the R&I sector.

This institutional framework does not rely on a strong programmatic component, leaving this task on the one hand to the specific sectoral policies and on the other hand on the organisations in charge of R&I promotion. Hence, environment and sustainability R&I are not coordinated through one national comprehensive agenda or strategy. Academic institutions and the main research promotion agency the Swiss National Science Foundation (SNSF) emphasize the overriding importance of

academic freedom in Switzerland. In contrast, federal policy research is strongly guided by needs, strategies and agendas specific to each policy sector.

Federal policy research defines as the research initiated and directly financed by entities of the federal administration, whose findings serve the authorities and political actors in the fulfilment of their tasks. For most of the policy sectors, federal policy research accounts for a small proportion of research expenditures at the national level, and research activities are generally outsourced to third parties. In environment, federal policy research accounts for about 2% of the federal research expenditures in the sector and is commissioned to numerous public academic partners as well as the private sector. The current status of Switzerland as 'non associated third country' within the framework programme Horizon Europe has an undeniable effect on research collaborations with European partners in comparison to a participation as associated country as prior to 2021.[22].

Recent budget saving plans of the Swiss Confederation also include cuts in the education, research and innovation sector for 2025–2028 which will consequently negatively impact Switzerland's research and innovation capabilities. The research policy directly reduces the resources available to academic institutions for conducting scientific projects, limit opportunities for researchers, and it is suspected that this contributes to a decline in the quality of research. Most large-scale conventional funding instruments remain, whereas new and innovative instruments are cut off.

When examining the different actors' research and innovation priorities in sustainability, it becomes evident that the need to understand and work on societal transformation processes is a fundamental cross-cutting theme and common thread of the various sustainability challenges. While distinct priority areas such as resilient, net-zero, circular production systems; biodiversity and climate; sustainable urbanization; and nature-friendly energy transitions each demand specific attention, their successful implementation inherently depends on broader societal transformation processes. This perspective raises critical questions about how science and research can effectively support such transformative changes. It would ask from the scientific community to much more strongly transcend its traditional role as mere observers and analysts, becoming active participants in transformation processes while maintaining scientific rigor, i.e. distinguishing evidence from value judgments when engaging in normative visioning. This is particularly relevant as current approaches to transformation

[22] According to the interviewed experts, this status changes significantly the ability to lead research projects funded by Horizon Europe and reduces involvement in collaborative projects that are central to European research. Swiss researchers can still participate in around two thirds of the Horizon Europe calls, but with restricted roles, and they must rely on Swiss government funding rather than EU funds. In the current status as a non-associated third country in Horizon Europe, funding for Swiss participants in collaborative projects is secured by the State Secretariat for Education, Research and Innovation (SERI) for positively evaluated projects as part of the transitional measures. Participation in mono-beneficiary projects is in principle not possible as a non-associated third country. For these non-accessible calls for proposals, SERI provides funding through temporary instruments that are implemented either by SERI itself, the SNSF, Innosuisse or ESA. With the start of negotiations between Switzerland and the EU in March 2024, the EU put in place the transitional arrangement 2024, which allows researchers in Switzerland to participate in the Advanced Grants 2024 call of the European Research Council (ERC) as 'beneficiary'. Due to progress in the negotiations, the EU has decided that researchers in Switzerland will be eligible as 'beneficiaries' for the first three calls for proposals of the ERC in the 2025 programme year. If no association agreement has been concluded at the time of Grant Agreement signature of these calls, SERI will directly fund the Principal Investigators with positively evaluated proposals. For up-to-date information, please visit: www.horizon-europe.ch

have been criticized for their predominantly technocratic focus on economic and technological solutions.

A more comprehensive understanding of transformation processes requires critical examination of existing frameworks and enhanced attention to social innovations and the dynamics of individual and collective actions. By recognizing societal transformation as a cross-cutting theme, we can better understand how different sustainability priorities interact and how they collectively contribute to systemic change, thereby enabling more effective research and innovation strategies. As such, there is a pressing need to better understand the ‘how’.

13.1.2. Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Social innovation for resource-light economies We need to understand how to effectively design and implement incentives and regulations that can drive the transition to a circular economy. We currently face complex conflicts between different sustainability goals and transformation paths that need to be resolved. Additionally, we need to better understand how non-regional production impacts spatial planning, and how subsidies and taxation can be optimally structured to support this transition.	A	• Develop effective policy instruments that integrate incentives and regulations for circular economy implementation. • Resolve conflicts among various transformation goals through cohesive policy design. • Establish clear, actionable pathways for circular economy initiatives. • Gain insights into how production patterns influence spatial planning. • Produce evidence-based recommendations to reform subsidies and taxation. • Support balanced, sustainable transformation in economic and environmental systems.	I
Equitable structural change Economy transformations inherently create winners and losers in society, which potentially lead to social upheavals. Understanding these dynamics, including their side effects, is crucial as these changes need to be anticipated and managed in equitable ways to prevent deepening social inequalities during sustainability transitions.	S, T	• Enhance understanding of structural change processes and their social side effects. • Enable the development of strategies to mitigate negative social impacts. • Promote more equitable approaches to managing economic transitions. • Anticipate and address potential social upheavals proactively. • Ensure sustainability transformations benefit society as a whole. • Prevent the creation of new social disparities during economic transitions.	I

Economic and financial systems The current economic and financial systems often tolerate or even promote unsustainable practices. The disconnection of finance from the real economy and the prevalence of speculative and manipulative financial markets have led to significant economic and financial instability.	S, A	• Develop economic and financial systems that align with sustainability goals. • Foster more stable and equitable economic practices. • Reduce negative environmental impacts through sustainable financial practices. • Promote a more equitable distribution of wealth and resources. • Build a resilient global economy that supports long-term sustainable development. • Strengthen the economy's capacity to support sustainable transformation on a global scale.	I
Fair and inclusive value chains We need to fully understand the roles and impacts of different actors, from production to logistics and consumers. This knowledge is critical for designing circular economy models that are equitable, sustainable, and effective across the entire value chain.	A	• Enable the design of more comprehensive circular economy concepts that integrate all actors fairly. • Clarify roles of various actors across entire value chains. • Enhance collaboration and coordination among stakeholders. • Support the development of targeted strategies for circular economy implementation. • Improve efficiency and sustainability within value chains.	I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

13.1.3. Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Ecosystem regeneration Research on Ecosystem Regeneration is urgent and important because we face critical questions about implementing environmental protection in a socially just way, particularly regarding CO2 compensation regulation and climate politics. There is an urgent need to understand and address the negative side effects of net-zero policies, such as landscape degradation from energy production and spillover effects in foreign countries. Additionally, we need to better understand carbon storage and consumption patterns. The urgency is heightened by the need to develop resilient, biodiverse systems while understanding how different production modes and economic models impact ecosystem health, and how local communities can be effectively involved in nature-based solutions.	*A*	• Development of socially just approaches to ecosystem regeneration • Effective frameworks for regulating CO2 compensation • Understanding and mitigation strategies for negative side effects of net-zero policies • Improved knowledge of carbon storage and consumption mechanisms • Identification of production modes and economic models that support resilient ecosystems • Clear understanding of nature-based solutions and effective ways to involve local communities in their implementation • Pathways to achieve resilient, biodiverse systems	N, I
Understanding the balance between prevention and resilience regarding climate change We need to better understand complex trade-offs and synergies in land use decisions that affect both biodiversity and climate, particularly in the context of food and energy production. We need to understand both quantitative and qualitative aspects of land use and soil consumption. Additionally, there is an urgent need to better comprehend the broader value of biodiversity beyond climate services, including its implications for health, pandemic prevention, food security, and cultural aspects.	*S, T*	• More specific data and expertise about what constitutes an optimal balance between prevention and resilience of climate disasters from a Swiss perspective • Better understanding of trade-offs and synergies in land use decisions affecting biodiversity and climate • Improved knowledge of both quantitative and qualitative aspects of land use and soil consumption • Comprehensive understanding of biodiversity's value beyond climate services, including its role in health, pandemic prevention, food security, and culture	N

There is a pressing need to understand what constitutes an optimal balance between preventing climate change and disasters and building resilience to them. Furthermore, we need to develop effective ways to communicate about both climate and biodiversity issues.		• Development of effective communication strategies for climate and biodiversity issues	
Implication of climate metrics and indicators There is a major challenge in developing effective monitoring systems for biodiversity and climate protection and adaptation. Currently, there is significant uncertainty about responsibilities and a lack of clarity regarding best practices in sustainability assessments and climate impact evaluations. We need to better understand how different indicators can be made coherent and harmonized, and crucially, we need to develop a deeper understanding of what these indicators actually reveal beyond their numerical values.	*A*	• Development of coherent and harmonized climate metrics and indicators • Better understanding of how to effectively use and interpret these indicators • Clearer definition of responsibilities in climate monitoring and assessment • Establishment of best practices for sustainability assessments and climate impact evaluations • More transparent and meaningful interpretation of climate-related data and measurements	R, N, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

13.1.4. Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Sustainability oriented spatial development and urban transition At the forefront stands the pressing demand for climate change adaptation, which requires cities to fundamentally rethink their energy planning and spatial organization. Current urban development patterns pose a significant threat to vital natural resources, as they continue to encroach upon forests, agricultural lands, and valuable landscapes.	*A, T*	• Development of energy-efficient neighbourhood concepts ("Energiequartiere") • Creation of alternative, more sustainable living models • Implementation of compact development strategies that preserve natural and agricultural areas • Integration of cultural and historical aspects into urban transformation	R/N

The urgency is further amplified by existing social challenges within our urban structures. Many cities struggle with social segregation and fail to adequately address the diverse needs of different generations. Moreover, traditional urban planning approaches are increasingly proving insufficient in managing climate-related challenges, such as water management and heat stress, highlighting the immediate need for innovative solutions like the "Sponge City" concept. Inefficient urban patterns often fail to support sustainable lifestyles. This is evident in how certain urban patterns are structured around car dependency and inefficient land use, making it difficult for residents to make sustainable choices in their daily lives. The concept of the 15-minute city exemplifies why research is needed to understand how we can transform urban spaces to better support sustainable living patterns, where essential services are easily accessible and where mobility, housing, and individual choices can align with sustainable development goals.		• Achievement of socially inclusive urban spaces that reduce segregation • Development of climate-resilient urban solutions (like "Sponge City") • Creation of accessible cities where essential services are within 15-minute reach • Establishment of diverse, intergenerational housing solutions • Better alignment of individual choices (mobility, housing) with sustainable land use.	
Urban-rural disparities The issue extends beyond simple geographical differences to complex interconnections involving mobility systems, resource distribution and economic opportunities. Understanding agglomeration effects and their impact on both urban and rural development is crucial. Moreover, there's an urgent need to address the imbalance in mobility infrastructure, which affects quality of life and economic opportunities. The current traffic systems, particularly in rural areas, are unsustainable and inequitable, going beyond just the transition to electric vehicles.	*A, S*	• Development of fair and efficient mobility solutions connecting urban and rural areas • Better understanding and management of resource flows between urban and rural areas (food, industrial products) • Recognition and preservation of rural landscapes' unique value and functions • Creation of more balanced agglomeration patterns that benefit both urban and rural areas • Implementation of innovative traffic systems that move beyond traditional car-centric approaches • Design of equitable transportation systems that serve both urban and rural populations	R/N

**KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]*

13.1.5. Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need[23]	What impact is expected to be achieved by focusing on these priorities? Mention the time span[24]	On what level will this impact take place?[25]
Social aspects of a sustainable energy transition The transition raises fundamental questions about sufficiency (how much energy we really need) and efficiency (how to best use energy) that affect society at all levels. There's a critical need to understand the economic implications for different social groups and to develop appropriate policy mechanisms that ensure a fair transition. Without proper research into these social dimensions, even technically sound solutions might fail due to public resistance or uneven social impacts.	*S/T*	• Clear understanding of sufficiency and efficiency concepts in the context of energy use • Development of equitable economic frameworks for energy transition • Creation of effective policy mechanisms and governance structures • Establishment of public engagement strategies that ensure informed participation • Development of legal frameworks that protect public interests during the transition • Implementation of more sustainable energy generation through public support and participation.	N
Optimizing energy production and regional planning of energy systems Traditional energy management approaches are insufficient for handling the inherent instability of renewable energy sources like solar and water power.	*S/A*	• Development of AI-powered systems to balance fluctuating renewable energy production • Creation of advanced management systems for stable energy supply • Integration of artificial intelligence in both energy production and consumption control	N/I

[23] Systemic [S] / Actionable [A] / Transversal [T]
[24] Short term < 10 years / Long term >20 years
[25] Regional [R] / National [N] / European [E] / International [I]l

The increasing complexity of energy systems requires more sophisticated control mechanisms, particularly as we move beyond simple digitalization. The need to ensure stable energy supply while integrating variable renewable sources makes this research crucial for successful energy transition.		• Implementation of smart building management systems • Achievement of more reliable and efficient sustainable energy production systems • Better understanding of how technical innovations can enhance energy system stability	
Sustainable energy mix This is particularly critical in contexts like Switzerland, where complex trade-offs exist between different energy sources' environmental impacts. The issue is further complicated by the need to understand various stakeholders' roles (companies, collectives, private households) and to develop effective subsidy structures. The political and social dimensions of these choices make it essential to base decisions on thorough research rather than assumptions.	*S, A*	• Development of models for optimal power/energy mix configurations • Clear understanding of different stakeholders' roles in energy production • Creation of efficient and sustainable subsidy frameworks • Comprehensive comparison of environmental impacts across different energy sources • Understanding of political implications and social acceptance factors • Guidelines for implementing collective and private energy production systems	N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

13.1.6. Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Societal transformation processes and just transition The current approaches to sustainable development has been criticized as too technocratic or overly focused on the economic dimension.	*S, T*	• Enhanced understanding of the social, political, economic, and technological dimensions of transformation, moving beyond narrow technocratic approaches. • Insights into how to foster more inclusive, participatory, and equitable transformation	R/N/I

There is an urgent need to develop a more holistic, participatory, and reflexive understanding of societal transformation in order to drive the systemic changes required for sustainability. Additionally, the priority of a "just transition" is closely connected, as transforming underlying structural problems to support sustainable development implies the need for fair and equitable transition processes that address social disparities and promote cohesion.		pathways that address social disparities and promote cohesion. • Guidance on the role of science and research institutions in actively shaping and supporting societal transformation, rather than merely observing it. • Strategies for mobilizing the substantial time and financial resources required to meaningfully engage with and steer complex transformation processes. *Short to long term*	
Democracy and Participation How to effectively respond to pressing sustainability problems within democratic systems. The urgency stems from the need to understand how democratic processes can be leveraged to address sustainability challenges that require immediate action. There is a critical need to investigate alternative policy instruments, particularly regarding 1) how to respond to the urgency of the problems we face within a democratic system, 2) the effects of subsidies and alternative incentives, 3) learnings from other types of environmental policies and governance framework in other countries		• Insights into how democratic systems can better respond to urgent sustainability challenges • Knowledge about effective policy instruments and incentive structures that work within democratic frameworks • Practical lessons from international comparative analyses of environmental policies and governance systems • Understanding of how to enhance policy coherence and cross-sector cooperation within democratic contexts	
Environmental policy, law and governance There is a critical need to understand how multi-level governance compares to traditional federalist approaches in addressing environmental challenges. Current environmental laws must be assessed for their effectiveness and equity, particularly in ensuring accountability of governments, corporations, and other stakeholders.	*A, S*	• Improved understanding of multi-level governance effectiveness in environmental context • Assessment of current environmental laws' impact on equity • Development of new regulations aligned with international sustainability commitments • Creation of accountability frameworks for various stakeholders • Better understanding of courts, international law, and civil society roles in enforcement	R/N

Without proper research into policy coherence and cross-sector cooperation, administrative approaches to sustainability may remain fragmented and ineffective.		• Solutions for improved policy coherence across different sectors • Framework for cohesive administrative approaches to sustainability across contexts	
Health and wellbeing Research on health and wellbeing requires urgent attention as a standalone priority, not just as a subsidiary topic to other environmental issues. There's a crucial need to understand the complex relationships between climate change and health outcomes. The focus has traditionally been on negative impacts, but we urgently need to research how environmental changes and policies can positively influence health and wellbeing. The current lack of harmonization between environmental and health policies makes this research particularly important.	*S, T*	• Identification of positive interventions to enhance health and wellbeing • Better understanding of climate-health relationships • Development of harmonized environmental and health policies • Comprehensive mapping of health risks related to environmental changes • Creation of integrated approaches that promote both environmental and health benefits *Medium to long-term*	N/I
Agrarian transitions for sustainable food systems Agrarian transitions are crucial to address the numerous challenges posed by the current global food systems, which rely heavily on high-input, high-output practices. These systems have led to severe environmental consequences, including soil degradation, biodiversity loss, water scarcity, and overuse of pesticides. Additionally, globalized food systems contribute to social inequalities, particularly affecting small-scale agriculture in the global South. This priority requires a dedicated focus on food systems as a core theme, addressing the full spectrum of social, economic, and ecological impacts, as well as spillover effects from international trade.	*S, T*	• Development of sustainable, resilient, and equitable food production and consumption practices. • Reduction of environmental harm from agriculture, including improvements in soil health, biodiversity conservation, and water use. • Enhanced food security and improved public health through better dietary practices. • Innovation in agricultural and food technology, leading to sustainable practices that benefit both people and the planet. • Creation of advanced methods for assessing sustainability, true cost accounting, and fostering collaboration across technology and knowledge levels within the food value chain. *Long-term*	N/I

Geopolitical conflicts By examining the governance of global resource flows and the social, economic, and environmental spillover effects, we gain a more complete picture of how these conflicts influence global sustainability efforts. Additionally, understanding geopolitical dynamics in times of both peace and conflict is essential, as these factors profoundly impact the transition to a more sustainable production system and society.	*T*	• Insights into how shifting geopolitical frameworks can drive innovation and adaptive strategies for sustainability. • A deeper understanding of how conflicts affect global resource flows, helping to mitigate negative social, economic, and environmental impacts. • Evidence-based recommendations for governance structures that support resilience and sustainability amid geopolitical tensions. • Enhanced capacity to anticipate and manage the long-term impacts of geopolitical dynamics on sustainable development goals.	I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

13.2 Promising funding schemes

Switzerland possesses a number of funding bodies and instruments that support sustainability research and innovation, including the Swiss National Science Foundation (SNSF), federal funding through policy federal research (Ressortforschung), Innosuisse, and private foundations. The private sector also plays a significant role in funding research, according to Federal Statistical Office, in 2020 the private sector (including foundations) spent 365 Mio. CHF in ES R&I, which is to 28% of the total of funding in Switzerland in 2020. Despite the solid Swiss funding landscape, there is a consensus among the NKS that better-coordinated funding mechanisms are essential for cultivating a robust ES R&I community.

To address environmental and sustainability challenges, the NKS recommend that funding programmes take a systemic, cross-sectoral approach. They view long-term, programmatic funding models that support transdisciplinary research and effective science-policy integration as critical. Incentivizing and enabling transdisciplinary collaboration should involve providing seed funding for the development of purpose-driven, multi-stakeholder research projects and networks, as well as dedicated funding to support partner engagement. Capacity building of researchers and reviewers as well as evaluation mechanisms that do justice to integrated research approaches are among key features of successful interdisciplinary and transdisciplinary funding schemes. Mercator Foundation, for instance, provides seed money for risk-oriented approaches that involve experimentation and testing, with the involvement of local governments, think tanks, NGOs, practitioners and researchers support starting highly interdisciplinary projects. This type of funding allows and aims to test innovative ideas and obtain preliminary results to apply for larger grants, with a focus on impactful collaboration.

The NKS emphasize the need for strategic alignment between funding schemes, highlighting the importance of linking basic research, applied research, policy and market-near innovations. Critical for this purpose is a cohesive overall funding structure, one that can integrate impact-oriented research and innovation for sustainability. This ensures funding at the critical interface between basic research and science-based innovation. BRIDGE, for example, is a joint programme of the SNSF and Innosuisse, highly valued for offering this type of funding. Another example are National Research Programmes (NRPs). Although their thematic focus is determined by the Federal Council they are academically independent and long-term oriented. As such, they are relevant for and have an indirect impact on policymaking.

Mechanisms to facilitate collaboration and provide dialogue forums for different stakeholders are also deemed essential by the NKS. They recommend expanding the governance structure of funding programmes to include a broader range of stakeholders and experts beyond the traditional research community. Furthermore, funding should be long-term, programmatic and in support of effective science-policy integration. The SNSF-funded Agora programme promotes dialogue and network-building, for example.

According to the NKS, ES R&I funding must encourage flexibility and experimentation. Researchers should be empowered to pursue unconventional forms of scientific collaboration and output, such as real-world laboratories and social innovation pilots. For instance, the SNSF funded NCCR living labs can initiate system transformation by exploring the interrelations of technical innovation, cultural aspects, and behaviour.

This adaptability is seen as crucial for addressing the complexity of sustainability transformations. Underpinning these programmatic elements, significant investment in building and advancing respective capacity of researchers that work on sustainability issues is recommended. Dedicated resources for training, networking, and evaluation are viewed as essential.

Cited by several NKS, the report on Lighthouse Programmes in Sustainability Research and Innovation highlights engaging a broader range of stakeholders, supporting long-term and interdisciplinary projects, and focusing on real-world applications and impacts to be essential steps for advancing ES R&I.

13.3 Improving the Science Practice Policy interface (SPPI)

The interaction between science, policy, and practice in Switzerland is characterized by a multitude of activities of governmental bodies, academic institutions, and intermediary organizations. According to the NKS, Switzerland's direct democracy requires efficient communication channels between these entities to ensure that scientific research informs policy and practice effectively. The typical short decision-making path and political militia system in Switzerland is crucial for science practice policy interactions (SPPI). It also involves the challenge of identifying whom to address and who best represents society with respect to a specific issue.

Federal agencies and governmental stakeholders serve as the primary forums for policy advice in Switzerland. These bodies possess the necessary financial, specialist, and organizational resources to process advisory knowledge, drawing on in-house scientific expertise as well as externally commissioned studies from federally funded institutions, cantonal universities, or private research institutes. The national parliament, a key institutional arena, relies heavily on these agencies for input due to its limited capacity to process knowledge. Parliamentary commissions do, however, organize hearings to consult representatives from various sectors, including science and society. Extra-parliamentary commissions, comprising researchers, public administration officials, and representatives from cantons and municipalities, further supplement expertise and facilitate stakeholder involvement and policy implementation monitoring. For instance, the Swiss Science Council (Schweizerischer Wissenschaftsrat) provides systemic research policy advice to the Federal Council.

Academic institutions are also actively engaged, leveraging media presence, events, publications, and citizen science initiatives to bridge the gap between research and society. One notable initiative mentioned by interlocutors is the research project “Engage” (2023-2026), involving institutions such as ETH Zurich, EPFL, Eawag, Empa, and WSL. The project aims to foster an evidence-informed dialogue on policy options, applied research, and the development of interaction formats, thereby building capacity for effective science-policy engagement. Initiatives like Engage and the creation of platforms such as the Science-Policy Interface unit at ETH Zurich support bridging the gap between research and policy, ensuring that research findings are effectively communicated to policymakers.

The Center for Climate Impact and Action (CLIMACT) at UNIL and EPFL, for instance, organized 'Rencontre Participative Science – Politics' events[26]. They successfully fostered understanding, addressed frustrations between researchers, politicians, and media professionals and, most importantly, created direct communication channels and personal bonds.

Intermediary organizations such as the Swiss Academies of Arts and Sciences (a+), Reatch, Expedition Zukunft, the Sustainable Development Solutions Network Switzerland (SDSN), the Geneva Science Policy Interface (GSPI), and the Geneva Science and Diplomacy Anticipator (GESDA) and others specialize in facilitating science-policy interactions and are correspondingly seen as crucial knowledge brokers. Further, a number of NGOs also organize events, workshops, policy dialogues, and develop policy briefs that foster communication and collaboration between scientists, policymakers, and practitioners. Formats such as science lunches for members of parliament, policy fellowships, round tables, and collaborative workshops enable direct and meaningful dialogue, promoting evidence-based decision-making.

The NKS agree that SPPI does not necessarily need to be initiated and conducted by researchers themselves; it can be facilitated by those working at the science practice policy interface or through professionalised communication channels. Nevertheless, capacity building and training has been stressed as being significant in improving SPPI.

Funding mechanisms that dedicating time and resources to allow team members to effectively exchange, collaborate and build cohesive projects would improve overall coherence across project work packages. NKS suggest to improve interdisciplinary and cross-sectoral collaboration through long-term funding, which allows research initiatives the necessary time to build trust and align the ambitions of a project with the actual capacity to implement ideas. This will furthermore help prevent the risk of overpromising and reduce potential stakeholder fatigue in case stakeholders are asked to actively participate in the research process. Furthermore, enhancing a research consortium structure is essential for effective SPPI.

Finally, dedicated science-practice-policy exchange mechanisms and spaces for stakeholder engagement should be created. These would provide researchers, practitioners and policy actors with opportunities to discuss needs, expectations, and implications of research results openly. Such engagement helps to ensure that research outputs are more likely to be adopted and institutionalized within relevant policy frameworks, maximizing the impact of science practice policy collaboration.

[26] Rencontre Participative' was a form of interactive gathering that brought together representatives from different sectors of society, such as science, politics, business and the media. This type of event transcended traditional communication formats and enabled a direct, constructive dialogue between actors who normally work in separate spheres.

13.4 Recommendations for CASRI by NKS

- NKS raised the issue regarding the capability of finding the resources within their organisation to engage in such a project. Many organisations can afford to give up some of their time to take part in a workshop or answer an interview, but this may not be enough to actively engage and contribute to the content of the project. Provided such associated costs cannot be covered by the project, it is essential to be able to provide a concrete overview of the benefits for the NKS to be expected as early as possible (these varying widely depending on the type of organisation). Efforts made as part of the project must be understood as an investment with clear returns, such as future channelized funding opportunities specifically regarding the ES topics identified, leverage effect on the EU research work programmes (rely on examples where such SRIA was directly used to formulate calls, partnerships, etc.), streamlining multinational funding, identifying international partners, etc.
- The relevance of stakeholder's groups that are conventionally not considered in the R&I scene have been emphasised many times. The involvement of these often-overlooked actors is crucial, in particular for topics such as ES where the grand challenges that we are facing can only be addressed by systemic transformations affecting society as a whole and involving a transition in the value system. The integration of such stakeholders should be a focus of CASRI and ensured throughout the process, i.e. from the project co-design to the definition of eligible applicants for potential joint implementation of the SRIA.
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13.5 Reflection on the workflow

The information gathered reflects input from a limited sample of 21 NKS across a broad range of expertise. Most of the participants are actively involved in research, funding or represent intermediate organizations or associations, which may have influenced the perspectives shared. Other potential interviewees from the private sector were afraid they had little to add to the discussion. Thus, the diversity of responses was clearly limited.

During the research process, certain elements were refined to improve clarity and relevance. Early on, some information that seemed redundant or overly specific was removed to focus on broader themes and patterns. As the project evolved, additions were made to capture emergent themes and concerns raised by stakeholders. This iterative refinement allowed the study to balance depth with representativeness and ensured that the final analysis was aligned with the overarching objectives of the CASRI project.

The desk study primarily involved examining agendas and existing documentation, providing a formal and structured understanding of policy and research priorities. In contrast, the interviews revealed a more nuanced and cross-cutting perspective. Interviewees were often reluctant to commit to specific thematic priorities and instead emphasized a critical view of the purpose and relevance of research agendas. Many participants expressed a preference for addressing broad, cross-cutting issues rather than focusing on narrowly defined topics. The workshop introduced yet another shift in focus. Rather than discussing specific research needs, participants emphasized the importance of understanding broader transformational processes. There is probably a bias due to the fact the most of the interviewees and workshop attendees are «generalists», either because they stand on the funding side, or because they are in charge of large and thematically broad range of topics.

Only 12 of the 21 interviewees attended the workshop, with some sending substitutes. However, we also benefited from inviting additional 4 workshop participants whom we could not meet for individual interviews, including representatives from organizations such as Euresearch, the Swiss competence centre regarding EU research programmes and SERI. Their perspectives added significant value to the discussion, enriching the dialogue with new insights. Despite this, it became apparent that representatives from associations and NGOs often faced constraints—particularly in terms of time—and some felt too far away from the subject to fully engage, which limited their participation.

Looking back, there are several workflow adjustments that could enhance the process if repeated. First, dedicating more time after the workshop for analysis would have been beneficial, allowing for a more thorough integration of insights before drafting the final report. Additionally, having a clearer understanding of the final report's format from the outset could have streamlined the reporting process, potentially avoiding the need for major revisions of the interim report. In terms of workshop organization, attracting practitioners posed a challenge, and the participation of some NGOs was limited due to resource constraints. Future iterations might consider alternative engagement methods, such as shorter sessions, to make participation more feasible for stakeholders with limited availability.

Last but not least, the NKS approach with 21 interviewees only allowed creating a limited picture of research needs, funding options and SPPI. This picture is strongly shaped by individual views, although in the case of Switzerland, there was quite a large overall agreement among NKS on key points.

14 WALES – National/Regional Report

Author: Kester Savage

Country report specific abbreviations

AHRC	Arts and Humanities Research Council
BBSRC	Biotechnology and Biological Sciences Research Council
CCW	Countryside Council for Wales
DEFRA	Department for Environment, Food & Rural Affairs
DESZN	Department for Energy Security and Net Zero
EAW	Environment Agency Wales
ENCA	nature conservation agency
ERC	European Research Council
FCW	Forestry Commission Wales
NERC	Natural Environment Research Council
NRW	Natural Resources Wales
SMNR	Sustainable Management of Natural Resources
SoNaRR	State of Natural Resources Report
UKRI	UK Research and Innovation
WCPP	Wales Centre for Public Policy

EXECUTIVE SUMMARY IN ENGLISH

The national context in Wales is shaped by its groundbreaking legislative framework, including the Well-being of Future Generations (Wales) Act and the Environment (Wales) Act. These laws, coupled with the broad remit of Natural Resources Wales (NRW) as the environmental protection agency (EPA) and the nature conservation agency (ENCA), position Wales uniquely in addressing integrated environmental and sustainability challenges.

This review primarily focuses on the themes of **resilient net-zero circular production systems and climate and biodiversity**, reflecting NRW's broad remit and its capacity to drive change through public, private and third sector partnerships. Despite a concentrated focus, the robust legislative framework and rich insights from workshops enable meaningful contributions across all four CASRI themes.

Environmental and Sustainability R&I Needs:

- Identified priorities include innovative approaches to behavioural change, circular economy business models, and sustainable agricultural practices.
- The importance of integrating biodiversity conservation with economic activity was emphasised.

Funding Opportunities:

- Workshops and interviews highlighted funding streams such as UKRI Challenge Fund and Welsh Government Innovation Funding.
- Stakeholders emphasised the need for funding mechanisms that promote long-term thinking and equitable resource allocation.

Science-Policy-Practice Interaction (SPPI):

- Strong legislative support facilitates SPPI, but challenges remain in bridging gaps between policy and practice.
- Collaboration across sectors and enhanced community engagement were identified as priorities.

In summary, Wales' unique legislative and policy context, combined with the insights from this review, offers significant opportunities to address sustainability challenges through innovative research and collaboration.

14.1 Reviewed, synthesised and prioritised ES R&I needs and gaps

14.1.1. National research context

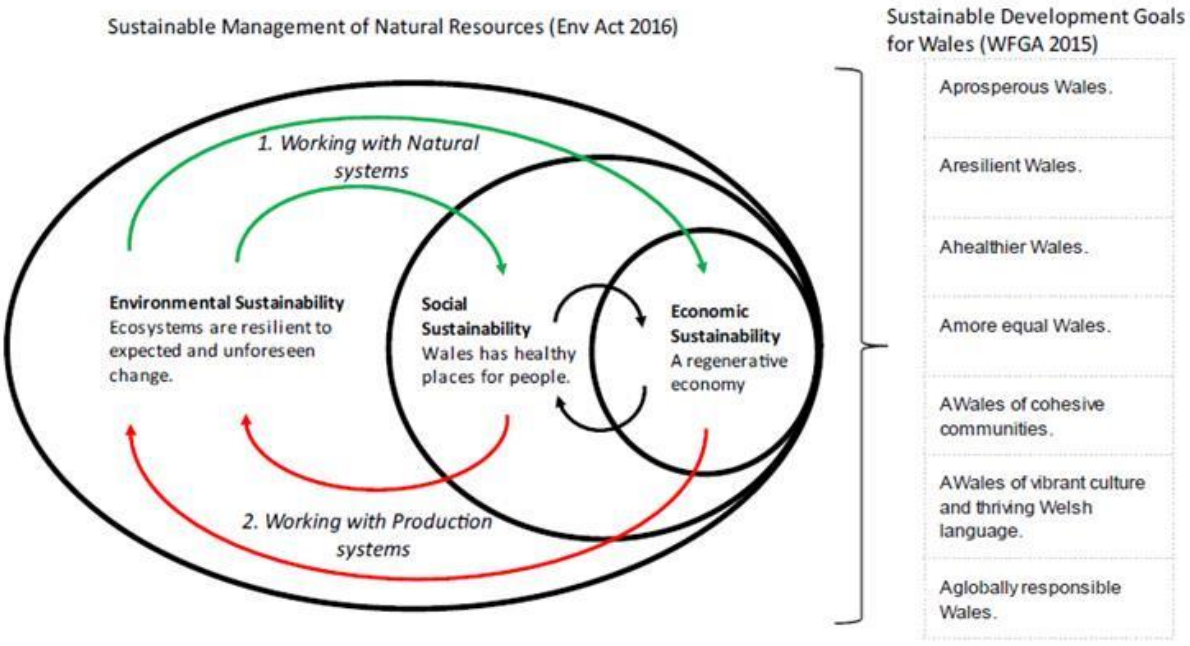

FIGURE 14-1: RELATIONSHIP BETWEEN ENVIRONMENTAL SUSTAINABILITY AND SUSTAINABLE DEVELOPMENT IN THE WELSH POLICY FRAMEWORK

Figure 14-1 illustrates how Wales's unique policy and legislative framework attempts to integrate the environmental, social, and economic dimensions of sustainability, aligning closely with the nation's approach to delivering the UN Sustainable Development Goals (SDGs).

Under the Well-being of Future Generations Act (2015) and the Environment (Wales) Act (2016), this approach advocates for Sustainable Management of Natural Resources (SMNR) as a means of safeguarding and enhancing ecological systems.

By "working with natural systems," resilient ecosystems form the foundation for healthier communities, which, in turn, support economic activity that respects and maintains the environment's adaptive capacity through "working with production systems."

This integrated approach ensures that environmental resilience supports social well-being, allowing communities to thrive and cultivate economic prosperity without overtaxing natural systems. In doing so, environmental stability, social cohesion, and economic strength serve as mutually reinforcing elements of sustainable development.

Natural Resources Wales (NRW), as the largest Welsh government sponsored body has a very wide remit and a significant role to play in responding to this legislation and upholding the principles of SMNR as set out in the Environment (Wales) Act 2016.

NRW was formed in 2013 when the legacy bodies, Countryside Council for Wales (CCW), Forestry Commission Wales (FCW) and Environment Agency Wales (EAW) merged and created a single organisation responsible for, amongst other duties, environmental protection, incident response, land management and maintenance of flood defence.

NRW acts in an advisory capacity to Welsh government, making evidence-based decisions for the benefit of Welsh communities and the environment. NRW is also Wales' environmental regulator, responsible for the management of licences which concern the management and exploitation of natural resources.

Natural Resources Wales contributes to this agenda through its reporting to Welsh Government in its State of Natural Resources Report (SoNaRR), its advisory and regulatory responsibilities, and its corporate plan.

The sustainability goals highlighted in these groundbreaking pieces of legislation are the sustainable management of natural resources, safeguarding and enhancing biodiversity and the resilience of ecosystems and to manage adaptively, considering the long term impact of decisions. NRW's goals as set out in its corporate plan are nature's recovery, resilience to climate change and minimising pollution. These priorities were echoed through the rich documentation retrieved through the desk study and by national key stakeholders through the workshop we led in Cardiff in November.

14.1.2. Resilient, net-zero, circular production systems

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Innovative approaches to encourage behavioural change Behaviour change of businesses and consumers across areas such as travel, consumption, waste and energy use is fundamental to bring about reductions in emissions and resource use.	S	Fostering widespread behavioural change in the short term will support the transition to a more sustainable, low-carbon economy, benefiting both the environment and society in the long term	R, N (strategically), E&I
"Innovative product design with a whole-life approach" Identified as a research need by Defra and prioritised by delegates, designing out waste and obsolescence is urgent to mainstream reductions in waste and resource consumption	A, T, S	Encourage the development of circular economies, minimising the need for virgin resources and reducing landfill and pollution. This should be accompanied by a cultural shift to embrace products which are created from or contain high proportion of upcycled material and nurture a repair and re-use economy. Whilst we can expect current innovation in the circular economy in Wale to continue to gain pace in the short term, the cultural shift required to fully realise this innovation need is medium/long term.	N, R
Circular economy business models Identified as a priority by delegates and a number of policy and strategy documents. It's important for innovative approaches to materials re-use to be scalable, efficient and economically competitive to be an accessible and viable alternative to conventional models for businesses and consumers across demographics	S	A paradigm shift away from single-use products and a preference for virgin materials, to a business model that mainstreams circular production at scale so sustainable resource use can be both affordable and desirable. With the policy framework in place in Wales, these are changes we can expect to continue progressing in short to medium term with significant long-term benefits.	R, N

Innovation across farming systems and agriculture With such a high percentage of land in Wales being used for agriculture there is an urgent need for innovation in agricultural methods and land use to enhance biodiversity and reduce environmental depletion, whilst maintaining and improving the resilience of the food supply in an equitable way	A, S, T	Innovation across farming systems and agriculture can be expected to enhance biodiversity and reduce environmental depletion in Wales over the medium to long term, while simultaneously maintaining and improving the resilience of the food supply. A sustainable balance between environmental conservation and food production, potentially achieved within a 5–10 year time span, depending on the implementation and adoption of innovative practices.	R, N
Societal and educational innovation; awareness and information As our scientific understanding keeps pace with a rapidly changing environment, there is an urgent need for robust education and reliable information to address the proliferation of misinformation circulating across all media and sense of powerlessness and confusion being felt by the public.	A, S, T	To empower the public with reliable knowledge, combat the spread of misinformation, and alleviate feelings of powerlessness and confusion. Over the short to medium term (e.g., 3–7 years), these efforts aim to build a well-informed society capable of making evidence-based decisions and actively participating in addressing environmental challenges, as scientific understanding continues to evolve.	R, N (strategically), E&I
Integration across the "innovation ecosystem"; innovations in governance to connect government, society and other actors Utilising and expanding existing networks to facilitate trans and interdisciplinary collaboration across sectors is essential to efficiently identify R&I needs and implement innovations through an adaptive management approach	S, T, A	To promote the exchange of knowledge, expertise, and resources, facilitating the rapid development and implementation of innovative, testable, sustainable solutions. An adaptive management approach will enable stakeholders to respond more effectively to evolving challenges and ensure that innovations are continuously refined and applied in ways that meet societal and environmental needs. Against the current policy framework we can expect progress in the short/medium term.	R, N - E&I (collaboration & knowledge transfer)

Innovative finance solutions to support local authorities to transition to new zero The WCCP identifies a need for local authorities to build capacity to identify and utilise innovative forms of finance, often from the private sector, to support their transition to net zero	S	Building capacity within local authorities to identify and utilise innovative forms of finance, will play a pivotal role in supporting their transition to net zero. This will help authorities to meet ambitious carbon reduction targets and foster further innovation while creating jobs in sustainable sectors. This can be expected to start having an impact in the short term	R
Reduction of energy demand through innovation, principally in the built environment and industry Reducing energy demand through innovation in the built environment and industry is crucial for a just transition, ensuring energy affordability and accessibility while lowering emissions that disproportionately impact vulnerable communities. By prioritising equity and environmental justice, this approach helps achieve climate goals while fostering economic and social resilience.	S, T, A	Significant reductions in emissions, particularly benefiting vulnerable communities disproportionately impacted by climate change. Over the medium to long term (e.g., 5–15 years), this approach aims to ensure energy affordability and accessibility, create green job opportunities in retrofitting and efficient design, and support workers transitioning from traditional industries. By prioritising equity and environmental justice, these efforts contribute to achieving climate goals while enhancing economic and social resilience, and creating opportunities for green jobs, particularly in retrofitting and efficient design, supporting workers transitioning from traditional industries.	R, N
Innovation in materials use for resilience and to achieve net zero. Innovating in material use is vital for building resilience and achieving net zero, ensuring sustainable resource use while reducing emissions and waste. By developing circular economy practices and advanced materials, we can lower environmental impacts and create durable infrastructure that supports communities through climate challenges.	A, S	Over the medium to long term (e.g., 5–15 years), this approach aims to lower environmental impacts through circular economy practices and advanced materials while creating durable infrastructure to support communities facing climate challenges. By fostering economic opportunities in sustainable industries, it ensures a just transition that balances environmental, social, and economic needs.	N, E, I

Reducing hazardous chemicals in products Reducing hazardous chemicals in products is essential for protecting human health and the environment, particularly for vulnerable communities disproportionately exposed to toxic substances. Innovation in safer alternatives supports a just transition by fostering sustainable industries, reducing pollution, and ensuring equitable access to healthier, safer products.	A, S	Implementation in the short to medium term (e.g., 5–10 years), innovations in this area will reduce pollution, promote safer alternatives, and ensure equitable access to healthier products. The long term impacts for human health and the environment will be significant	N, E, I
Advancements in bioplastics and other alternatives with lower environmental impact Ongoing innovations in alternatives to oil derived plastics to be upscaled to reduce costs and become familiar mainstream materials. This must be implemented together with better consumer education to avoid contamination of plastic recycling streams with bioplastics	A, S	Reduction in the amount of new plastic being used and entering product lifecycles and the environment, whilst reducing the dependence on fossil fuels. Impacts on soil health, marine and aquatic environments, and human health. (short-medium term implementation with long term impact)	R, N, I
Innovations in the cost, scale and effectiveness of retrofitting homes Poor housing stock represents a huge source of avoidable carbon emissions and is a urgent concern for tackling inequalities as the most economically deprived live in the most inefficient housing.	A	Innovations in retrofitting homes is expected to reduce avoidable carbon emissions and tackle inequalities by improving inefficient housing for economically deprived communities. Over the medium term (e.g., 5–10 years), this approach aims to enhance housing efficiency, lower emissions, and address social disparities with powerful long-term impacts	R, N
Skills gaps in circular product design in construction Addressing skills gaps in circular product design in construction is critical for advancing sustainable practices, reducing waste, and lowering emissions.	S, T, A	A long-term strategy to train a new generation of designers, architects and construction experts to embed the most current knowledge about materials, sustainable design and climate justice.	R, N

Equipping the workforce with these skills ensures a just transition, fostering green jobs and supporting the shift to a resilient, low-carbon built environment.		This foundational change will support a just transition to a resilient, low-carbon built environment.	
Improving secondary material markets to drive recycling Improving secondary material markets is key to driving recycling, reducing waste, and supporting a circular economy. Strengthening these markets creates economic opportunities, lowers environmental impacts, and ensures a just transition by making sustainable practices accessible and equitable for all.	S, T	Improving secondary material markets is expected to drive recycling, reduce waste, and support a just transition to a circular economy. Over the medium term (e.g., 5–10 years), this shift will begin to reduce landfill and virgin material extraction, create regional and national economic opportunities.	N, E, I
Trade-off between primary resource extraction vs reclamation from waste streams Research question posed by Defra concerning natural resources harvested in the UK. “Ensuring that these products are produced and traded sustainably to the financial and broader benefit of the UK, without damage to the environment, involves a range of critical research questions.”	S	Detailed life-cycle assessment important to rationalise decision-making and prioritisation and allocate resources to where innovations and new processes will have the most impact, without disproportionate economic impact. As an acknowledged innovation need at UK government level as well as the priorities in Welsh legislation, we would expect progress on this in the short/medium term.	R, N
Digital innovation for resource efficiency Identified in Wales’ innovation strategy, development in this area will help to build on Wales’ reputation as a world-leader in waste management and recycling.	S, T, A	Digital and smart technologies will assist in efficiently identifying materials that are safe to re-use or recycle by providing information on their chemical make-up, and these approaches applied to materials in the built environment as well as smaller products will promote and accelerate sustainable practices, and benefit human health and safety.	R, N

		Progress has already been made against the waste management element of Wales's 2021 Innovation Strategy and we would expect further progress in this area in the short term with long-term benefits for resource efficiency, environmental safeguarding and human health.	
How can innovation in chemical production, use, and disposal across the supply chain minimise chemical-related risks, benefiting the circular economy and reducing pollution? A specific research need, identified by Defra and in line with the UK's 25 year environment plan	A, S	Innovation in this area could have far-reaching environmental impacts across agriculture, industry and domestic products with long term benefits to human health, ecosystem resilience and sustainability. As an acknowledged innovation need at UK government level as well as the priorities in Welsh legislation, we would expect progress on this in the short/medium term, with long-term benefits for environmental safeguarding and human health.	R, N, E, I

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

14.1.3. Biodiversity and climate

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Build collaboration between researchers, evidence providers and policy makers ; developing the evidence-base for transformative societal change at all levels of society and tiers of government Essential for an effective SPPI, collaboration was consistently raised by delegates and interviewees as the most effective catalyst to effective and efficient change.	T	Collaboration and adaptive management will help to build consensus and accelerate the delivery of prioritised innovation needs. This transversal, societal approach will also promote a just transition, ensuring that changes and innovations are delivered equitably and at pace, focussed where they are most needed. Repeatedly identified by stakeholders as a priority, collaboration and adaptive management are also part of Wales's legislative	R, N, E, I

Collaboration and the sharing of resources between those implementing changes and interventions in the environment can ensure a more efficient and transparent exchange of information about evidence needs and effectiveness in practice. This can help to refine the focus of research, reduce the duplication of effort, and the repetition of sub-optimal techniques. Agile, adaptive management approaches to nature-based solutions and other environmental management interventions can help to more quickly refine implementation strategies for the best outcomes for people and nature.		framework. As such, we can expect stakeholders and policy makers to continue to work in more collaborative and adaptive ways in the short term.	
Innovative governance and policy-making to financially de-incentivise harmful practices, incentivise conservation and sustainable management and to deliver change at pace Urgent need to review subsidies, and any other financial incentives, including those connected with lobbying, which may promote harmful practices or present barriers to regenerative processes. Particular emphasis is given in the literature to ending fossil fuel subsidies and investments and similarly carbon intensive industries such as aviation. The reliance of intense agriculture and fisheries on fossil fuels and subsidies is cited, as well as subsidies awarded directly to the agricultural sector which perpetuate practices that "cause declines in nature" (JNCC)	S, T	Ensuring financial instruments such as taxation and subsidies are appropriately aligned with regenerative processes will serve normalise beneficial and sustainable practices. Political changes can be expected in the short/medium term, which, if maintained, will yield long-term benefits for biodiversity, soil health and air quality, providing greater ecosystem services to people. These changes are already starting to happen at a UK level in the agricultural sectors who will receive payments for regenerative practices and those that mitigate climate change.	R, N

A just transition (human-rights based approach) to a wellbeing economy Reflected in a number of the key documents, including Welsh legislation, and prioritised by the NKS, there is consensus that the only acceptable transition to a sustainable economy is one that is equitable and considerate of human rights and wellbeing at every level. Both globally and on national level, the worst impacts of environmental degradation and iniquity of access to nature and ecosystem services are suffered by those who are economically and socially marginalised or minoritised. In addition, they are more often those who contributed least to the causes of the crises. Welsh Government's policy document "Wales Innovates" highlights the need, not only for scientific and technical innovation but also financial and social innovation to deliver the benefits equitably across society. The IPCC also states "Climate resilient development is enabled when governments, civil society and the private sector make inclusive development choices that prioritize risk reduction, equity and justice, and when decision-making processes, finance and actions are integrated across governance levels, sectors, and timeframes"	S, T	A just transition to a wellbeing economy ensures equity and human rights are at the heart of sustainability efforts, aligning with Welsh legislation and NKS priorities. This approach fosters inclusive growth, protects vulnerable communities, and promotes social and environmental resilience for a fairer future. Urgent action in the short term will have long-term social, environmental and health benefit from the level of local communities to the global scale of climate change mitigation, adaptation and social justice.	R, N
Transformative, innovative and transdisciplinary education	A, S, T	A long term (e.g., 10–20 years), systemic change focusing on transformative, innovative, and transdisciplinary education is expected to equip learners with the skills to address complex global challenges.	R, N, E, I

The polycrisis being experienced globally requires innovation and action in all sectors and disciplines working together. Transformative, innovative, and transdisciplinary education equips learners with skills to solve global challenges, fostering collaboration, innovation, and sustainable solutions. As outlined by the Kunming-Montreal Global Biodiversity framework, successful implantation requires "transformative, innovative and transdisciplinary education, formal and informal, at all levels, including science-policy interface studies and lifelong learning processes, recognizing diverse world views, values and knowledge systems of indigenous peoples and local communities"		This approach fosters collaboration, innovation, and sustainable solutions across disciplines, and empowers the public to challenge spurious claims and misinformation.	
Adaptation: "flexible, multi-sectoral, inclusive, long-term planning and implementation of adaptation actions" A recommendation from the IPCC and acknowledged by delegates, adaptation measures, implemented equitably are urgent for mitigating the effects of climate change now being felt globally, but most acutely by the global south.	S, T, A	Equitable, flexible, and inclusive adaptation measures are urgently needed to mitigate climate change impacts, particularly in the global south, but equally relevant in Wales and the wider UK/EU. Over the short to long term (e.g., 5–20 years), this approach supports resilience through multi-sectoral, long-term planning and action	N, E, I

Connecting people with nature Connecting people with nature is essential for a just transition, fostering equitable access to green spaces that improve wellbeing and resilience. It supports vulnerable communities, promotes environmental stewardship, and ensures everyone benefits from the shift to a sustainable, nature-based economy.	A, T	There is more scientific evidence and personal testimony than ever that links connection with nature to human health and economic prosperity. Finding new ways through education, our working lives and planning of our towns and cities will help to promote these benefits and foster a deeper connection and personal investment in the natural world and sustainable practices. Short term policy action, implemented within 5-10 years, this approach will have long term impact, ensuring equitable access to green spaces, supporting vulnerable communities and fostering a sustainable, nature-based economy.	R, N
Innovative agricultural practices to conserve biodiversity and ensure food security whilst reducing nutrients lost to the environment Innovation, in partnership with agricultural workers and landowners, is urgently needed to realise the benefits of sustainable land management without disenfranchising farmers and wider society	S, A, T	The benefits to more sustainable farming in Wales and elsewhere are significant and it was a recurring theme in our workshop. Through sensitive, evidence-led governance, agricultural land in Wales could deliver huge gains for biodiversity, provide wildlife corridors, carbon sequestration and enhance our food security. Policy changes are currently underway. We would expect implantation changes in the short term with benefits being felt most strongly in the medium/long term.	R, N
Governance to build consensus for climate action across all levels of society Governance to build consensus for climate action is vital for a just transition, ensuring inclusive decision-making that empowers all levels of society. This fosters equitable solutions, strengthens collaboration, and accelerates the shift to a sustainable and resilient future.	S, T	With targeted resources changes can be expected within 5-10 years. This long-term approach accelerates effective climate action and supports a sustainable, just and resilient future.	R, N

Barriers to the adoption of nature-based solutions (NBS) Addressing barriers to adopting nature-based solutions is crucial for a just transition, ensuring equitable access to sustainable practices. Overcoming these challenges fosters community resilience, supports vulnerable populations, and accelerates the shift to a nature-positive future.	A, S, T	Addressing barriers to adopting nature-based solutions in the short-term will accelerate their adoption in the short to medium term. Widespread adoption of NBS will deliver long-term benefits for biodiversity, ecosystem resilience, climate change mitigation and adaptation whilst supporting a just transition to a nature-positive society and equitable access to the human benefits of a SMNR.	R, N
Reduce pollution and its negative impacts to biodiversity Innovations to reduce pollution and its impacts on biodiversity will require action across the SPPI, protecting ecosystems and the communities that depend on them. This ensures healthier environments, supports vulnerable species, and promotes sustainable development.	A, S	Reducing pollution and its impacts on ecosystems will protect biodiversity, support vulnerable species, and ensure healthier environments for people and nature. Reducing pollution will also bring a wide range of significant benefits to human health and wellbeing, reducing avoidable deaths from air pollution and maintaining safe aquatic and marine environments. Immediate, short-term action is required to ensure avoidable deaths are minimised and GHG emissions are reduced for long term climate change mitigation.	R, N
Global finance for climate adaptation Global finance for climate adaptation is crucial for a just transition, ensuring vulnerable communities have the resources to build resilience against climate impacts. It promotes equity, supports sustainable development, and fosters global collaboration for a climate-resilient future.	S, T	Global finance for climate adaptation is expected to build resilience in vulnerable communities, promote equity, and ensuring urgent funds reach the communities that need them most. Over the medium to long term (e.g., 5–15 years), it fosters global collaboration for a climate-resilient future. Long term impacts will include mitigating the drivers for climate migration and conflicts arising from resource shortage and distribution	E, I

Tackle the intensity of drivers of biodiversity loss and reverse or reduce the risk of extinctions Innovative approaches to tackling the drivers of biodiversity loss and reducing extinction risks is vital to ensure local and regional ecosystem resilience as well as global migration patterns. Communities rely on biodiversity for livelihoods and wellbeing.	S, A, T	In the medium to long term, tackling biodiversity loss and reducing extinction risks will support ecosystem resilience and the integrity of global food webs. Urgent innovation in policy and practice will help to avoid species collapse and the chain of subsequent impacts on the global movements and lifecycles of species.	R, N, E, I
Connectivity and resilience of ecosystems and protected sites, including habitat creation at a large scale Enhancing ecosystem connectivity and resilience, including large-scale habitat creation, is important to protect biodiversity, strengthen natural defences against climate impacts, and ensure equitable access to the benefits of healthy ecosystems.	A	Large scale project delivery in the short to medium term can be expected to deliver benefits for generations to come through climate change mitigation and adaptation, carbon sequestration and the enhanced resilience of biodiverse ecosystems	R, N
Innovate to improve climate resilience in agriculture, forestry and fisheries Innovation to improve climate resilience in agriculture, forestry, and fisheries is important to ensure sustainable food systems, protecting livelihoods, and supporting vulnerable communities in adapting to climate impacts.	S, T	Beneficial impacts of climate resilience in food production must be at the heart of a just transition, protecting the natural environment through regenerative practices, and adaptive management, protecting industries and livelihoods and ensuring access to essential natural resources. Regenerative practices can be implemented and adaptively managed in the short/medium term	R, N

Minimise impact of ocean acidification caused by climate change Minimising the impact of ocean acidification is crucial to protect marine ecosystems and the livelihoods of communities that depend on them, while ensuring the resilience of ocean resources for future generations.	S, A	Addressing ocean acidification protects marine ecosystems, supports livelihoods reliant on the ocean, and ensures the resilience of ocean resources. Urgent action in the short term can be expected to deliver positive impacts in the medium to long term. This approach secures a sustainable future for communities and biodiversity. Failure to address this will result in the collapse of marine ecosystems and significantly compromise oceans' capacity to support life and sequester carbon.	N, E, I
Innovation in methods to monitor and assess terrestrial and marine ecosystem resilience and ecological condition Developing innovative methods to monitor ecosystem resilience enables data-driven decisions that protect biodiversity, promote sustainable resource use, and help communities adapt to environmental challenges.	A, S	In the short to medium term, investment in technology and more effective use of reliable data will help us to monitor ecosystems with a higher degree of accuracy and efficiency, alert us to changes and enable us to focus resources where they will deliver the greatest impact for people and nature in the long term	R, N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

14.1.4. Sustainable urbanisation

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Urban ecosystem restoration	A, S	Revitalising urban ecosystems improves biodiversity, enhances air and water quality, and provides essential ecosystem services for urban resilience and liveability.	R
Tackling the urban heat island effect	A, T	Mitigating heat stress reduces energy demands, improves public health outcomes, and enhances urban liveability, especially in vulnerable communities disproportionately affected by extreme heat.	R
Green & Blue Infrastructure	A, T, S	Embedding nature-based solutions ensures that urban areas achieve net-zero targets, restores natural systems, and reduces pollution while enhancing recreational and mental health benefits for communities.	R,N
Integration of sustainable transport with urban green spaces	A, T	Promoting active transport (walking, cycling) alongside green corridors reduces emissions, improves physical health, and fosters community connections.	R
Retrofitting urban areas for biodiversity	T, S	Enhances urban biodiversity, mitigates climate risks, and aligns built environments with ecosystem-based adaptation strategies.	R
Addressing air and noise pollution through urban greening strategies	A, S	Improved public health outcomes, reduced healthcare costs, and enhanced quality of life for urban residents through noise reduction and cleaner air.	R

Urban water management and flood mitigation	T, S	Resilient water systems reduce flood risks, improve water quality, and enhance urban resilience to climate-related challenges.	R,N
Accessible green spaces for equity in urban design	A, S	Equitable access to green spaces promotes mental and physical well-being, addresses urban inequalities, and strengthens social cohesion.	R
Urban planning to support circular resource use and waste reduction	T, S	Aligning urban development with circular economy principles minimises waste, promotes resource efficiency, and reduces environmental footprints of cities.	R,N
Leveraging digital innovation for urban sustainability	A, T	Smart technologies enable better planning, monitoring, and management of urban ecosystems and infrastructure for greater efficiency and sustainability.	R

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

14.1.5. Nature & environmentally friendly energy transition

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
Decarbonising energy production through renewable sources	A, T	Reduces greenhouse gas emissions, mitigates climate change, and promotes energy security by transitioning from fossil fuels to renewables like wind, solar, and tidal energy.	N,I
Advancing energy storage solutions	T, S	Improves grid resilience and reliability by enabling efficient storage and distribution of renewable energy, addressing intermittency challenges.	R,N
Scaling up Nature-Based Solutions (NbS) for energy infrastructure	A, T, S	Enhances ecosystem resilience while integrating renewable energy projects, such as solar farms with	R

		pollinator habitats or wind farms with marine conservation zones.	
Reducing energy demand in the built environment	A, T	Lowers emissions through innovations in energy efficiency, retrofitting, and smart technologies, contributing to both net-zero goals and healthier living environments.	R,N
Supporting just transitions in energy systems	S	Ensures equity by addressing the social and economic implications of transitioning to renewables, particularly for vulnerable communities reliant on traditional energy sectors.	R,N
Innovation in circular energy systems	T, S	Promotes resource efficiency by reusing materials in energy infrastructure, reducing waste, and fostering circular economies in energy production and distribution.	N,I
Reducing the environmental impact of energy infrastructure	A, T	Minimises biodiversity loss and ecosystem disruption through sustainable site selection, design, and mitigation strategies for renewable energy projects.	R
Policy innovation to incentivise renewable adoption	S	Encourages uptake of renewable energy through subsidies, tax incentives, and regulations, driving systemic change across energy production and consumption patterns.	N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

14.1.6. Other themes / crosscutting themes

R&I Priorities – and why urgent and/or important?	Kind of knowledge need*	What impact is expected to be achieved by focusing on these priorities? Mention the time span**	On what level will this impact take place?***
How best to work with socio-ecological systems; [taking a regenerative approach as part of a holistic, just transition]	A,S	Prevents wasting finite resources while combining societal considerations. Promotes ecological resilience and equity across communities, ensuring long-term sustainable outcomes.	R, N, E, I
Co-benefits of active transport and green infrastructure	T	Mental and physical well-being improvements, particularly for less affluent communities. Reduction in emissions and enhanced urban green spaces.	R, N
Managing conflict and contestation in sustainability transformations	S	Develops strategies for navigating shared and contested values in decision-making processes, fostering inclusive approaches to sustainability.	R, N, E, I
Addressing socio-economic impacts in consumer-driven economies	A,T	Tackles challenges posed by consumerism, promoting equitable lifestyles and sustainable consumption patterns.	R, N
Corporate and environmental ethics; CSR and ESG	A,T	Explores strategies to engage businesses effectively in addressing “wicked” problems, fostering corporate accountability, and promoting sustainable practices.	N, E, I
Governance; direct, [proportional] democracy (pros and cons) and the importance of actively seeking diverse voices and involving them in the decision making process	S	Enhances diverse representation and inclusion in governance, promoting proportional democracy to improve sustainability transformations.	R, N
Decolonialism and environmental justice	T	Integrates decolonial perspectives and ensures equitable environmental policies, reducing systemic inequalities and historical injustices.	N, E, I

Addressing disincentives in political and economic systems	S,T	Identifies and mitigates systems that discourage long-term sustainability actions, enabling a shift toward proactive, future-focused governance and economics.	N, E, I
Research on cultural ecosysytem benefits that build identities, experiences and capabilities; our ccultural factors of consumption; ingrained expectations, concepts of success, status, reward; the dopamine “hit” of quick consumption	S,T	Builds understanding of how cultural identity, experiences, and capabilities intersect with ecosystem services, fostering sustainable and inclusive policy development.	N
Role of arts, humanities, and storytelling	T,A	Inspires cultural and societal change through STEAM approaches, providing hope and framing challenges in accessible, meaningful, and locally relevant ways.	R, N

KIND OF KNOWLEDGE NEED: SYSTEMIC [S] / ACTIONABLE [A] / TRANSVERSAL [T], **TIME SPAN: SHORT TERM < 10 YEARS, LONG TERM >20 YEARS; ***LEVEL: REGIONAL [R] / NATIONAL [N] / EUROPEAN [E] / INTERNATIONAL [I]

14.2 Promising funding schemes

Core sources of funding identified through the desk study, workshop and interviews are:

- UKRI Challenge Fund, supporting businesses and researchers to tackle major industrial and societal challenges, including clean growth
- EU LIFE Programme supporting environmental and climate action projects on research and innovation, environmental sustainability and resource efficiency
- Interreg Europe, facilitating regional cooperation across Europe, including Wales
- EUREKA Network
- COST (European Cooperation in Science and Technology)
- BBSRC (Biotechnology and Biological Sciences Research Council)
- NERC (Natural Environment Research Council)
- AHRC (Arts and Humanities Research Council)
- Horizon Europe (2021-2027), which is open to Welsh researchers despite Brexit arrangements, focussing on global challenges, climate action and sustainability
- ERC (European Research Council)
- Welsh Government Innovation Funding, supports projects which align with Welsh Government's priorities on Natural Resource Management
- OFWAT Innovation Fund
- Industrial Energy Transformation Fund (funding from DESNZ for delivering energy & resource efficiency measures in industry)
- Faraday Institute

Other contributors and delegates confirmed the importance of Welsh Government funding.

The availability and effectiveness of funding streams depends on the specific area of research being investigated. One interview which focussed on the need for diversity in research and representation of innovation needs was the only contributor to the project who emphasised the importance of National Lottery funding in enabling research and action in her field.

It was acknowledged through the workshop activities that there was an increasing number of private companies funding research as well as a role being played by philanthropy from industries

Workshop delegates raised concerns or suggestions around the funding mechanisms, and the need for particular approaches such as:

- Funding specifically targeted at retrofitting for climate adaptation whilst working with nature
- Revenue funding for monitoring, evaluation and maintenance
- Funding specifically promoting long-term thinking
- Acknowledging the disparity between private and public funding, posing the question, how far can we go with public money?
- Precarity of funding and reliance on volunteerism for core functions such as biodiversity monitoring

14.3 Improving the Science Practice Policy interface (SPPI)

It has been widely acknowledged that Wales boasts one of the most ambitious environmental legislative programmes in the world, exemplified particularly by the Wellbeing of Future Generations Act, 2015 and the Environment (Wales) Act, 2016. The SPPI is facilitated primarily by Welsh Government's policy agenda and NRW, with cross agency networks, academic research groups and third sector organisations creating a broad and active environmental sustainability sector. Despite this, significant challenges still exist in implementing and enforcing this legislation against a backdrop of stretched public funding, organisational silos and the pressures of a consumerist society.

The ethical and scientific imperative of a just transition and the co-benefits that this will bring to society globally have been largely identified as cross-cutting due to the action required across themes and the far-reaching impacts and benefits that this approach will have; however, it is important to recognise the considerable implications that this has for the SPPI.

Whilst the SDGs are enshrined in Welsh legislation, work remains to be done to bridge the gaps between policy and practice and delegates recognised the need to raise equity across all citizens in Wales.

Historical barriers to innovation and the just transition were acknowledged[27], and issues such as systemic racism, colonial history and class inequalities need to be confronted to ensure that there is representation at every stage of the SPPI to deliver innovations that bring positive changes for all society. The consideration of global implications to actions taken in Wales must be embedded from project design to implementation. This will require innovation in workflow design and funding criteria.

The need for more effective collaboration across networks in science, practice and policy was reiterated through all of the workshop activities. The priorities emphasised by delegates included the need to make more effective use of our existing networks, but also to ensure research draws on the expertise from across different areas of expertise and meaningfully represent a diversity of thought and viewpoints when assessing possible solutions. The need to better share and transfer data, knowledge and resources within and between organisations was identified as a challenge, and a suggestion was made to explore the use of AI to more easily attain and synthesise results, outcomes and evaluations. Evaluation was also raised as a challenge for discrete projects carried out with specific funding streams. It's crucial for evaluation to be robust and made easily accessible to inform future practitioners and researchers.

The need for collaboration extends beyond regional or national networks to collaborating closely with international partners across science, policy and practice, however powerful examples of this are already happening between Welsh and Nigerian institutions, evidenced by one of our interviewees who leads such partnership projects.

[27] These were discussed in greatest detail through a Futures Triangle workshop activity whereby delegates contributed to a Mural board to suggest historical determinants, current pressures, and future trends, which included both concerns for the future and the hopes of progress.

Community engagement and a commitment to facilitate meaningful contributions from citizen scientists was also given as a way to strengthen the SPPI, with emphasis placed on empowering local communities and involving them in policy formulation

Whilst collaboration was identified as a challenge, a number of opportunities were identified, with existing networks being highlighted, some of which were represented by delegates at the workshop. Existing networks (see Appendix A) referred to or represented by delegates were: CAST, Cerig, CEIC, Climate Action Research Institute, Land Use for Net Zero (LUNZ), South Wales Industrial Cluster, the Wales Net Zero 2035 Challenge Group and the Cross Agency Evidence Group. The Well-being of Future Generations National Stakeholder Forum was identified as an important network for supporting the implementation of the Act. Linking with the private sector was also identified as an opportunity to make progress through collaboration.

Challenges were highlighted across the agricultural sector to enable more sustainable food production, with emphasis placed on the need to invest in regenerative agriculture, maximising biodiversity and carbon sequestration, for example through peatland restoration and increased tree cover, and integrating nature recovery with food production.

It was recognised that there is a need to make sustainably produced food, and other sustainable consumer choices accessible to those on low incomes. Ongoing work in this area, including examples of published reports, was raised at the workshop.

14.4 Recommendations for CASRI by NKS

Recommendations for CASRI by NKS

The insights gathered from interviews and workshops highlight several key areas for CASRI to address in advancing Environmental and Sustainability Research and Innovation (ES R&I). Strengthening transdisciplinary collaboration is essential to bridge gaps between researchers, policymakers, businesses, and communities. This requires breaking down organisational silos and addressing resource disparities that hinder effective cooperation. Emphasising the integration of diverse perspectives, particularly those from underrepresented groups, will ensure that solutions are equitable and inclusive.

A focus on equity and justice must underpin all sustainability efforts. Principles of environmental justice and decolonialism should be incorporated to confront systemic inequalities and historical legacies, ensuring that sustainability transitions deliver benefits for all sections of society. Additionally, governance structures must balance competing values and priorities, facilitating long-term thinking that aligns financial, societal, and environmental objectives.

Behavioural and cultural shifts are critical for fostering sustainable practices. Educational initiatives and public campaigns should challenge entrenched consumption patterns and promote active transport, circular economies, and other sustainable behaviours. The role of arts, humanities, and storytelling is vital in inspiring change and offering hope to counteract the despair often associated with global challenges.

CASRI should prioritise systemic research and action that address interconnected challenges across biodiversity, climate, production systems, and urbanisation. Regenerative approaches that integrate socio-ecological systems should be prioritised, particularly those that offer long-term sustainability benefits. Funding mechanisms must be innovative, supporting underfunded areas such as biodiversity monitoring and retrofitting for climate adaptation, while disincentivising harmful practices.

Improving the Science-Policy-Practice Interface (SPPI) is another crucial area for attention. Existing networks and emerging technologies, such as AI, can be leveraged to enhance data sharing and knowledge synthesis, streamlining decision-making processes. Community engagement must also be strengthened, with citizen science playing a pivotal role in shaping policies and monitoring outcomes.

Education and skills development are critical for building capacity to address sustainability challenges. Investments should be directed toward transdisciplinary education programs that prepare future generations with the knowledge and skills required to innovate in areas like circular design, sustainable agriculture, and digital tools for resource efficiency.

By addressing these priorities, CASRI can ensure that its Strategic Research and Innovation Agenda reflects the needs and aspirations of diverse stakeholders, driving impactful and inclusive sustainability transitions.

14.5 Reflection on the workflow

The workflow employed for the national comprehensive review was adapted from the CASRI methodology in order to maximise the insights from the review given the resources available (in tight time constraints). By incorporating a rigorous Delphi-style voting approach, we ensured that expert input was systematically prioritised and synthesised. This method enabled us to capture a balanced and actionable set of insights, even within the constraints of limited representation from National Key Stakeholders (NKS).

Despite these efforts, we acknowledge the limitations inherent in the sample of NKS consulted. Achieving a fully comprehensive and representative spread of stakeholders was unfeasible given the scope and timeline of this exercise. However, we view this as a starting point, with plans to build on this work by engaging new voices and exploring contested areas in the coming months and years through our expanding network.

To align with Wales' Well-being of Future Generations (Wales) Act, we also integrated futures exercises into the process. This foresight approach not only fulfilled legislative requirements but also provided valuable insights into emerging trends, uncertainties, and long-term sustainability challenges. These exercises proved particularly useful in framing research and innovation priorities within a broader, forward-looking context (see annex for Future Triangle method(s).

Recognising the interconnected nature of the CASRI themes, we employed systems mapping as a core analytical tool. This approach was pivotal in reconciling the complexity of the four CASRI themes with our adapted focus on "working with natural systems" and "working with production systems." Systems mapping facilitated a holistic understanding of the synergies,

trade-offs, and systemic challenges within these themes, and it offers a strong foundation for future work.

Lessons Learned and Future Adjustments

Our approach successfully balanced methodological rigor with practical constraints. However, some areas for improvement were identified. The reliance on existing networks, while efficient, limited the diversity of perspectives. Expanding outreach efforts to engage underrepresented voices will be a priority for future iterations. Additionally, while the systems mapping exercise was highly effective, more time and resources would have allowed deeper exploration of its outputs.

In retrospect, the inclusion of futures and systems approaches proved invaluable and should be retained in any future workflows. To enhance the impact of these tools, greater integration with stakeholder discussions and workshops would be beneficial.

Overall, this workflow has laid a strong foundation for ongoing engagement and refinement, providing a robust basis for Wales' contribution to CASRI and the broader environmental and sustainability research agenda.

Appendices

Appendix A: Overview of networks in which NKS are involved

This appendix presents 1) for each participation country or region an overview of relevant networks that the NKS are involved in, and 2) an overall overview of international networks that NKS are involved in.

National Networks

National Austria

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Allianz für nachhaltige Universitäten	Other: Sustainability research & education	1
2	Ausschuss Regionalwirtschaft (JTP-AG)	Energy Transition	1
3	Austrian Panel on Climate Change (APCC), 2nd Austrian Assessment Report Climate Change	Biodiversity & Climate	1
4	Austrian Platform for Research and Technology Policy Evaluation (fteval)	Other: RTI policy	3
5	Austrian Soil Science Society (ÖBG)	Biodiversity & climate	1
6	Austrias Energy (Brachenplattform)	Energy transition	1
7	Bildung für Nachhaltige Entwickung (BNE)	Biodiversity & climate	1
8	BIOS Science Austria	Biodiversity & Climate	1
9	Citizen Science	Biodiversity & climate	1
10	Climate Change Center Austria (CCCA)	Biodiversity & climate	2
11	Climate Hub	Biodiversity & Climate	1
12	Commission on the Defossilisation of the European Energy System at the Austrian Academy of Sciences	Energy transition	1
13	Fachbeirat für Bodenfruchtbarkeit und Bodenschutz (national advisory board on soil fertility and protection)	Biodiversity & climate	1
14	FWF Cluster of Excellence Materials for Energy Conversion & Storage	Energy transition	1
15	FWF Cluster of Excellence Microbiomes Drive Planetary Health	Biodiversity & climate	1
16	Klimawandelanapassungsnetzwerk (KWAN)	Network for climate change adaptation	1
17	Mission Innovation Austria	Energy Transition	1
18	Open Science Austria (OSA)	Other: RDI	1
19	Staatliches Krisen- und Katastrophenschutzmanagement (SKKM)	Other: Crisis management and disaster resilience	NA

	Bundeskanzleramt Krisensicherheitsbüro (Sammlung von Risikofaktoren)		
20	Österreichische Koordinationsstelle für Energiegemeinschaften	Energy transition	1

National – Basque Country

No	Name	Main CASRI theme(s):	Nr NKS involved
1	BRTA (Basque Research & Technology Alliance)	circular production systems; energy transition	6
2	RVCTI (Basque Network on Science Technology and Innovation)	circular production systems, biodiversity & climate, sustainable urbanization, energy transition	7
3	Basque Ecodesign Center	circular production systems, energy transition	1
4	Basque Excellence Research Centre	circular production systems, biodiversity & climate, energy transition	1

National Bulgaria

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Bulgarian Biodiversity Foundation (BBF) Network	biodiversity & climate	4
2	Association of Parks in Bulgaria	biodiversity & climate sustainable urbanization	3
3	Green Balkans Network	biodiversity & climate	5
4	Black Sea NGO Network	biodiversity & climate	2

National Finland

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Research Council of Finland	All topics	Single or some
2	The Strategic Research Council	All topics	Several
3	Finnish Science Panels (The Finnish Nature Panel https://luontopaneeli.fi/briefly-in-	All topics, emphasis on climate and energy	Several

	english/; The Finnish Climate Change Panel https://ilmastopaneeli.fi/en/etusivu-en/ ; Finnish Expert Panel for Sustainable Development https://www.kestavyyspaneeli.fi/en/; The Finnish Forest Bioeconomy Science Panel https://metsatiedepaneeli.fi/frontpage/)		
4	Finnish foundations	All topics	Several
5	Society of Scientists and Parliament Members (TUTKAS)	All topics	Single or some
6	Research and Innovation Council	All topics	Single or some
7	Ministries of Finland	All topics	Several
8	Finnish Business and Society (FIBS)	All topics	Single or some
9	Helsinki Institute of Sustainability Science (HELSUS)	All topics	Single or some
10	Finnish National Commission on Sustainable Development	All topics	Single or some
11	Uuden talousajattelun keskus (UTAK)	All topics	Single or some
12	Finnish Sustainable Communities (FISU)	All topics	Single or some
13	Forum of Environmental Information	All topics	Several
14	Finnish Academy of Science and Letters	All topics	Single or some
15	Carbon Neutral Finland (HINKU)	Climate change	Single or some
16	Luontokunnat https://luontokunnat.syke.fi/	Biodiversity	Single or some

Networks Flanders

Interviewees mentioned four types of relevant networks:

- Policy networks or multistakeholder networks, incl. technical working groups, steering committees etc.;
- Dedicated research/scientific networks;
- Networks or communities set up in the context of an EU project or partnership;
- Networks from industrial/private sector federations.

Most organisations are member of dozens of (up to 100) networks, thematic experts participate in networks on thematic topics (nature, biodiversity, water, land use planning, coastal challenges, forest, …) or implementation of international and EU legislation.
It is not really possible to select networks that are considered more impactful than others. The list below gives some examples of networks that were mentioned by more than one interviewee.

National Flanders

No	Name	Main CASRI theme(s):	Nr NKS involved
1	KIS – Knowledge Centre for Innovative soil remediation techniques and approaches (PFAS and emergent contaminants) – FL	Circular economy	2
2	Spearhead clusters	Other: Multistakeholder clusters, focus on Innovation	2
3	Working group research coordinators Policy Domain Environment	All topics	3
4	BE-ARMA - Belgian Association of Research Managers and Administrators	All topics (mostly HORIZON)	3
5	FLEHS - Flemish Center of Expertise on Environment and Health	Other: health & environment	3
6	VLAIO network	Multi-topic	2

National France

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Agences de programme : CEA – APED (energy transition) CNRS – CBSD (sustainable urbanization, biodiversity and climate) INRAE (biodiversity and climate, circular production system)	NA	NA
2	Les Groupements De Recherche (GDR) e.g Participatory Action Research and Citizen Sciences (PARCS)	NA	NA

3	Association pour une alliance sciences-sociétés (ALLISS)	NA	NA
4	Le Réseau des Créfad https://reseaucrefad.org/	NA	NA
5	Forum Urbain	sustainable urbanization	1

Networks Germany

The analysis of the relevant networks shows a diverse picture of networking in various areas of research areas of research, politics and business. **At the national level**, the Federal Ministry of Education and Research (BMBF) and the German Research Foundation (DFG) play a central role. Many experts are involved in BMBF initiatives such as Research for Sustainability (FONA) or the National Platform for Education for Sustainable Development. Further networks were mentioned merely once. **At European and international level**, the networks within the framework of Horizon Europe and the of the EU Commission are of great importance. UN organisations such as the UNECE Convention (CLRTAP) and the United Nations Environment Programme (UNEP) are also frequently mentioned as important networking platforms. as are subject-specific societies and associations such as the German Society for Educational Science, the International Water Association (IWA) and the Association of German Foundations.

However, even if there was no clear nucleus in the naming of relevant networks, a clear pattern was seen in the **interdisciplinary orientation of many networks**. Experts are often active in scientific, political and economic circles at the same time. This multi-level networking extends from the regional to the national and international level. There is a strong focus on research and innovation. Many of the networks mentioned aim to influence political decisions. This can be seen in their participation in policy advisory committees and in their involvement in strategic research and innovation agendas.

In the prioritisation of networks, research networks, particularly those of the BMBF and EU research programmes, appear to enjoy the highest priority. Specialised international associations also play an important role, as do policy advisory networks that influence decision-making processes.

National Germany

No	Name	Main CASRI theme(s):	Nr NKS involved
1	BMBF (Federal Ministry of Education and Research)	NA	5
2	German Research Foundation (DFG)	NA	1
3	Research for Sustainability (FONA)	NA	1
4	Federal associations, e.g. German foundations	NA	1

5	Federal Ministry of Housing, Urban Development and Building (BMWSB)	NA	1
6	DAFA: German Agricultural Research Alliance	NA	1
7	Association of German Scientists (VDW)	NA	1
8	DWA (German Association of Water Management)	NA	1
9	GWP – German Water Partnership	NA	1
10	Belmont-Forum	NA	1
11	German Research Institute for AI	NA	1

National Italy

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Botanical Gardens Networks	Biodiversity & climate	1
2	Italian Alliance for Sustainable Development (ASviS)	Circular production systems, Biodiversity and Climate, Sustainable urbanization, Energy Transition	3
3	National Technological Cluster – Blue Italian Growth	Circular production systems, Biodiversity and Climate, sustainable urbanization	1
4	Southeast European Network for Professionalization of Climate Change community (SELEM)	Biodiversity and Climate, sustainable urbanization	1
5	Agency for the Promotion of European Research (APRE)	Circular production systems, Biodiversity and Climate, sustainable urbanization	1
6	National Biodiversity Future Center (NBFC)	Biodiversity and Climate	2

7	Conference of Rectors of Italian Universities (CRUI)	circular production systems, Biodiversity and Climate, Sustainable urbanization, Energy Transition	1
8	Italian Network of Universities and Research Institutions for Public Engagement (APEnet)	circular production systems, Biodiversity and Climate, Sustainable urbanization, Energy Transition	1
9	Association of Foundations and Savings Banks (ACRI)	circular production systems, Biodiversity and Climate, Sustainable urbanization, Energy Transition	1
10	Cluster Agrifood	circular production systems, Biodiversity and Climate, Sustainable urbanization, Energy Transition	1
12	Cluster Spring	circular production systems, Energy Transition	1
13	Cluster forest	circular production systems, biodiversity & climate, sustainable urbanization, energy transition	1
14	National Agrometeorological Network (RAN)	circular production systems, biodiversity & climate	1
15	Permanent Observatory on Water Uses	circular production systems, biodiversity & climate	1
16	National Rural Network	circular production systems, biodiversity & climate	1
17	Network for the Valorization of University Research (Consorzio Netval)	circular production systems, biodiversity & climate	1

18	Soil-Hub	circular production systems, biodiversity & climate	1
19	National System for Environmental Protection (SNPA)	circular production systems, biodiversity & climate, sustainable urbanization	1
20	URBAN@IT	Circular production systems, Biodiversity and Climate, sustainable urbanization	1

Networks Ireland

In the interviews some responses were given on networks, but no consensus or anything that would represent more than an individual opinion. As such, networks are not included.

National Montenegro

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Office for Sustainable Development	biodiversity & climate Nature & environmentally friendly energy transition crosscutting themes	NA
2	Chamber of Economy of Montenegro	biodiversity & climate crosscutting themes	NA
3	Innovation fund of Montenegro	biodiversity & climate crosscutting themes	NA
4	Eco fund	biodiversity & climate	NA
5	Energy community	Nature & environmentally friendly energy transition crosscutting themes	NA

Networks Netherlands

Due to limited time in the interviews, networks were not inventoried.

National Slovakia

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Association of Geosciences	Biodiversity & climate	1
2	Association of cities and municipalities of Slovakia	Sustainable urbanization	1
3	Slovak Bioclimatological Society	Biodiversity & climate	1
4	National climate program of the Slovak Republic	Biodiversity & climate	1
5	Association of Industrial Unions and Transport.	Energy transition	1
6	RIS3 - Operation Programme for Research and innovation	All CASRI topics	1
7	SAPI RE Cluster	Energy transition	1
8	National Hydrogen Association	Energy transition	1
9	ERA Portal Slovakia - National Portal on the European Research Area	All CASRI topics	1
10	CVTI SR - Slovak Centre of Scientific and Technical Information	All CASRI topics	1

National Switzerland

No	Name	Main CASRI theme(s):	Nr NKS involved
1	Swiss Academies of Arts and Sciences (a+) Science et Cité TD-Net ProClim Forum Biodiversität Sustainability Research Initiative	Crosscutting	NA
2	Joint Initiative	Crosscutting	NA
3	ETH Rat	Crosscutting	NA
4	CLIMACT	Climate and Biodiversity	NA

5	Netzwerk von den kantonalen Nachhaltigkeitsfachstellen NKNF/Réseau cantonal du dévelopment durable (RCDD)	Crosscutting	NA
6	World Trade Institute (Bern)	Economy	NA
7	Oeschger Centre for Climate Change Research (OCCR)	Climate	NA
8	Center for Public Management (KPM)	Crosscutting	NA
9	Soziale Innovation Bern	Crosscutting	NA
10	U Change	Crosscutting	NA
11	Netzwerk Future	Crosscutting	NA
12	Federal Chancellery FCh	Crosscutting	NA
13	Swiss Science Council SSC	Crosscutting	NA
14	Circular Economy Switzerland	Circular production systems	NA
15	Bodenkundliche Gesellschaft der Schweiz / Societé Suisse de Pédologie	Biodiversity	NA
16	EspaceSuisse	Sustainable urbanization	NA
17	Sanu Durabilitas	Circular production systems, sustainable urbanization	NA
18	Dialog 2030	Crosscutting	NA
19	Alliance Süd	Crosscutting	NA
20	TA Swiss Folgenabschätzungsbehörde	Crosscutting Technology	NA
21	Circular Economy Transition	Circular production systems	NA
22	Impact Hub	Circular production systems	NA
23	Der Verband für nachhaltiges Wirtschaften ÖBU	Circular production systems	NA
24	Global Compact Network Switzerland and Lichtenstein	Circular production systems	NA
25	Competence Centre for Social Innovation	Circular production systems	NA
26	WWF Schweiz/Suisse	Biodiversity	NA
27	Swiss Cleantech	Energy transition	NA

28	Verband Schweizerischer Elektrizitätsunternehmen VSE / Association des entreprises électriques suisses (AES)	Energy transition	NA
29	Sustainable Switzerland NZZ	Circular production systems	NA
30	Swiss Green Economy Symposium	Circular production systems	NA

National Wales

No	Name	Main CASRI theme(s):	Nr NKS involved
1	CAST	Circular production systems	>2
2	CEIC Wales	Circular production systems	>1
3	CERIG	Circular production systems	>2
4	CIEEM - Net benefits for Biodiversity and the DECCA system	Circular production systems	>1
5	Climate Action Research Institute (Swansea University)	Biodiversity and Climate	>1
6	Cross Agency Evidence Group	All topics	>1
7	Land Use for Net Zero (LUNZ)	Biodiversity and Climate	>2
8	South Wales Industrial Cluster	Circular production systems	>2
9	Wales Net Zero 2035 Challenge Group	Circular production systems	>4
10	Well-being of Future Generations National Stakeholder Forum	All topics	>4
11	Wales Biodiversity Partnership	Biodiversity and Climate	2
12	Wales Innovation Network | Universities Wales	All topics	>5
13	Wales Environment Link	All topics	2

International Networks

Below, the international networks mentioned by the NKS are represented. In the last column, the country that mentioned the network and the amount of NKS that are member or have mentioned the network are indicated[28]. The Netherlands and Ireland have not provided networks because limited time in the interviews. In France, Finland, Germany and Switzerland no numbers are provided on how many NKS indicated that they are a member of the network.

CP= Circular production systems, BC = Biodiversity and climate, SU = Sustainable urbanisation, ET = energy transition, CC = Crosscutting

Below this international network table, some international organisations and funding instruments that were mentioned as networks are provided.

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
100 % Renewable Energy Reallabor				x			Austria (1)
Agri DataSpace	x	x					Italy (1)
Agricultural Chief Scientists of G20							Germany (NA)
AgriFood EDIC (European Digital Innovation Hub)	x						Italy (1)
Analysis and Experimentation on Ecosystems (anaEE)	x	x					France (NA), Italy (1)
Basel Convention's networks	x						Slovakia (1)
Belmont Forum		x					France (NA)
Biodiversa +		x					Italy (2)
Black Sea Commission		x					Bulgaria (2)

[28] NA= not applicable, the network was mentioned by NKS from this country but no numbers for NKS involvement were given

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
Botanic Garden Conservation International		x					Italy (1)
BRIDGE				x			Austria (1)
BusinessEurope	x	x	x	x			Italy (1)
C40	x	x	x				Italy (1)
CEEPUS	x	x	x	x			Slovakia (1)
Circular Cities and Regions Initiative (CCRI)	x						Flanders (3)
Circular Economy Research Center (CERC)	x						Finland (some)
Clean Energy Transition Partnership (CETP)				x			Austria (1)
Climate Adaptation EU Mission		x					Basque Country (5)
Climate Alliance		x					Slovakia (1), Switzerland (NA)
Climate Leadership Coalition		x					Finland (some)
Climate mitigation Network		x					Italy (1)
Climate Strategies Research Network		x				Research, technology and innovation Policy	Austria (1)
CMCC Foundation (Euro-Mediterranean Center on Climate Change)		x					Slovakia (1), Switzerland (NA)
Collaboration for Environmental Evidence						Global network assessing evidence synthesis in environmental	Wales (1)

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
						science, especially concerning the SPPI	
Common Forum - Common Forum on Contaminated Land	x					Soil	Flanders (3), Basque Country (2)
COPERNICUS Network		x					Austria (1)
Covenant of Mayors		x					Finland (some), Slovakia (1)
Deutsch-Österreichisches URBAN-Netzwerk			x				Austria (1)
Driving urban transitions to sustainable Europe			x				Germany (NA)
EARTH Global Climate-Tech Alliance			x			Research, technology and innovation Policy	Austria (1)
EARTO (European Association of Research and Technology Organisations)	x	x	x	x			Basque Country (5)
EC Scientific Advice Mechanism - microplastics evidence review		x					Austria (1)
ECLASS			x				Slovakia (1), Switzerland (NA)
ECOSYSTEX	x						Slovakia (1), Switzerland (NA)
EJP Soil - European Joint Programme on Agricultural Soil Management						soil	Flanders (2)
Energy and Managing Authorities Network (EMA)				x			Austria (1)
Energy Cities			x	x			Austria (1)
EPA network - Network of the Heads of European Environmental Protection Agencies			x				Flanders (3), Italy (1)

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
EPI-AGRI Agriculture and Innovation Network (EU CAP Network)	x	x	x	x		Rural and Agricultural Development	Slovakia (1), Switzerland (NA)
EU Horizon Partnership DUT - Driving Urban Transitions to a sustainable future– Partnership			x				Flanders (5)
Eurocities	x	x	x	x			Austria (1), Finland (some)
EURO-CORDEX e MED-CORDEX		x	x				Italy (1)
European Automobile Manufacturers Association				x			Slovakia (1), Switzerland (NA)
European Bauhaus	x	x	x	x			Slovakia (1)
European Business & Biodiversity Platform		x					Austria (1)
European Culture expressed in Agricultural Landscapes (EUCALAND)		x					Slovakia (1), Switzerland (NA)
European Ecological Federation (EEF)		x					Italy (1)
European Energy Network				x			Slovakia (1), Switzerland (NA)
European Environment Information and Observation Network (Eionet)	x	x	x	x			Finland (some), Italy (1), Slovakia (4)
European Food Safety Authority (EFSA)		x					Austria (1)
European Forum for Studies of Policies for Research and Innovation (Eu-SPRI)						Transformative and mission-oriented Research, technology and innovation Policy	Austria (2)
European Innovation Partnership (EIP)	x	x					Italy (1)

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
European Landowner Organization (ELO)	x	x				Land, Soil	Austria (1)
European Nature and Environment Agency (ENEA)		x					Austria (1)
European Network of Indicator Designers (ENID), (International Conference on Science, Technology and Innovation Indicators (STI Conference))						Research, technology and innovation indicators	Austria (1)
European Network of leading national innovation agencies (TAFTIE)						Research, technology and innovation programs & policy	Austria (1), Basque Country (1)
European network of Living Labs (ENoLL)			x				Austria (1)
European Plate Observing System (EPOS)		x					Italy (1)
European Regional Science Association (ERSA)						Sustainable Development	Austria (1)
European Regions Research and Innovation Network (ERRIN)	x	x	x	x			Basque Country (1), Italy (1)
European Research Infrastructure Consortium (ERIC)						Research Infrastructures	France (NA)
European Spatial Planning Observation Network (ESPON)						Spatial planning	Flanders (2)
Eye of Europe / Futures4Europe						Foresight, Future-oriented technology analysis	Austria (1)
Federation of European Academies (Allea)						Research policy and scientific advice	Austria (1)
Forum B7 e B20	x	x	x	x			Italy (1)
Forum Carpaticum		x					Slovakia (1)

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
Forum of European Road Safety Research Institutes (FERSI)			x	x			France (NA)
Future Earth					x		Switzerland (NA), France (NA)
Global Alliance for Inter- and Transdisciplinarity (ITD)					x		Switzerland (NA)
Global Earth Observation (GEO)		x					Italy (1)
Global Land Programme					x	Crosscutting land (agendas)	Switzerland (NA)
Global Research Council					x	Innovation/Global South	Switzerland (NA)
Global Soil Partnership		x					Slovakia (1)
Global Water Partnership		x					Slovakia (1)
Innovation Growth Lab Research network (IGL)						Research, technology and innovation Policy	Austria (1)
Integrated Carbon Observation System (ICOS)		x					France (NA), Italy (1), Slovakia (1)
Intergovernmental Panel on Climate Change (IPCC)		x					Switzerland (NA)
Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)		x					Austria (1), Finland (Some), Switzerland (NA)
International Energy Agency (IEA)				x			Switzerland (NA)
International Federation of Landscape Architects (IFLA) EUROPE			x				Slovakia (1)
International Long Term Ecological Research (ILTER)		x					Slovakia (1)

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
International Network for Environmental Management e.V. (INEM)		x					Austria (1)
International Network of Climate Change Centres of Excellence and Think-Tanks for Capacity Building (INCCCET)		x		x			Basque Country (1)
International Renewable Energy Agency (IRENA)				x			Switzerland (NA)
International Science Council (CIS)					x		France (NA), Switzerland (NA)
International Society of Arboriculture			x				Slovakia (1)
International Union for Conservation of Nature - IUCN		x					Bulgaria (15), Slovakia (1)
International Union of Forest Research Organizations (IUFRO)	x	x					Austria (1)
International Union of Soil Science (IUSS)		x					Austria (1), Slovakia (1)
International Water Association (IWA)						Water	Germany (NA)
IQ-net						Exchange of managing authorities on European Regional Development Fund programs	Austria (1)
Knowledge Centre for Biodiversity		x					Austria (1)
Land Use, Land-Use Change and Forestry (LULUCF)		x					Slovakia (1)
Local Governments for Sustainability (ICLEI)	x	x	x				Basque Country (1), Finland (Some), Italy (1)

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
NCP-networks of the EU	x	x	x	x			Germany (NA)
NICOLE - Forum on industrial sustainable land management						Soil, industrially managed land	Flanders (2)
Organisation for Economic Co-operation and Development (OECD)	x						Finland (Some), Switzerland (NA)
PARC – HORIZON Partnership for the Assessment of Risks from Chemicals	x					Chemicals	Flanders (3)
Partnership for Research and Innovation solutions in the Mediterranean Area (PRIMA) Foundation	x	x		x			Italy (1)
Philanthropy Europe Association (PHILEA)	x	x	x	x			Italy (1)
PIONEER - Alliance of European Universities	x	x	x				Italy (1)
Promoting Operational Links with Integrated Services (POLIS)	x	x	x				Italy (1)
Real Labore der Nachhaltigkeit (DE)					x		Switzerland (NA)
Science Advice for Policy by European Academies (SAPEA)					x		Austria (1)
Science Europe					x		Switzerland (NA)
Scientist coalition for an effective plastic treaty		x					Austria (1)
Soil Revolution		x				Soil	Montenegro (1)
Sustainability Transition Research Network (STRN)	x	x	x	x			Austria (3), Finland (some)
Sustainable Consumption Research and Action Initiative (SCORAI Europe/Global)						Sustainable consumption	Austria (1)

International networks	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
United Nations (UNDP,UNDOPS)	x					sustainable development, innovation, Research, technology and innovation policy	Montenegro (5)
UNECE Convention (CLRTAP)							Germany (NA)
UNEP Plastics Initiative	x					Research, technology and innovation policy	Austria (1)
United Nations Environment Programme (UNEP)	x	x	x	x			Bulgaria (4), Germany (NA), Montenegro (5)
United Nations Global Compact	x	x	x	x			Finland (Some)
United Nations Ocean Conference UNOC 2025		x					France (NA)
UNESCO Bridges							Wales (1)
URBACT			x				Austria (1)
Urbinat international network of Observer Cities and Institutes			x				Flanders (2)
Water Europe						Water	Germany (NA)
German Advisory Council on Global Change (WBGU)					x		Switzerland (NA)
World Wide Fund for Nature (WWF) - Danube-Carpathian Programme		x					Bulgaria (6)
Zero Emissions Enterprise (ZEE) network		x					Austria (1)

CP= Circular production systems, BC = Biodiversity and climate, SU = Sustainable urbanisation, ET = energy transition, CC = Crosscutting

International organisation (mentioned as network by NKS)	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
Czech Bioclimatological Society		x					Slovakia (1)
European Environment Agency	x	x	x	x			Finland (some), Slovakia (3)
European Environmental Bureau (EEB)	x						Austria (1), Finland (Some), Slovakia (1),
European Forest Institute		x					Slovakia (2)
European Soil Data Centre (JRC-ESDAC)		x				Soil	Slovakia (1)
Institute for Sustainable Technologies (AEE Intec)			x	x			Austria (1)
Institute of development studies					x		Switzerland (NA)
International Energy Agency (IEA)				x			Finland (Some), italy (1), Slovakia (1)
Joint Research Centre - JRC	x	x	x	x			Slovakia (1)
LE:NOTRE Institute			x				Slovakia (1)
NUT-GIGAKU				x			Basque Country (1)
US Environmental Protection Agency (USEPA)	x	x	x	x			Slovakia (1)

CP= Circular production systems, BC = Biodiversity and climate, SU = Sustainable urbanisation, ET = energy transition, CC = Crosscutting

International funding instrument or organisation (mentioned as network by NKS)	CASRI themes					Other	Countries (nr of NKS involved in the network)
	CP	BC	SU	ET	CC		
Agence de la transition écologique ADEME (French)					x		Switzerland (NA)
Cost Actions		x					Italy (1)
ERA-NET							France (NA)
EU Life							Wales (1)
EU Mission in Horizon Europe					x	Policy dialogue	Switzerland (NA)
Horizon Europe	x	x	x	x			Bulgaria (17), Finland (several), Germany (NA), Montenegro (2), Slovakia (3),
INTERREG Europe	x	x	x	x			Slovakia (1)
IPA Fund - Instrument for Pre-accession Assistance	x	x	x	x			Montenegro (2)
Net Zero Cities EU Mission			x	x			Basque Country (2)
Soil EU Mission			x			Soil	Basque Country (1)
Widening participation and strengthening the European research area (NCP_WIDERA.NET)						Transnational Cooperation	Austria (1)

Appendix B: Literature list

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Appendix C: Questionnaire interviews

Blue text = explanation to interviewer (NC)

Black text = questions to interviewee (NKS). **Bold: core of the question**, not bold, further elaboration of question or follow up questions

Preparation/Desk study

- ***Translate the questionnaire to your own language**.*
- ***Familiarise yourself with the questions** so you know what questions are coming and you can switch between the questions when this is logic in the line of your interview.*
- *Make sure you **come prepared to the interviews** and perform a good **desk study**. Fill out the questions yourself as far as you can **before the interview**:*
    - *Part B - Interview information: all*
    - *Part C - Background information on interviewee: Q5*
    - *Part D - Strategic Research Agendas: Q7*
    - *Part E - Funding: Q9*
- *Please **send the filled-out interview questionnaire beforehand** to the interviewee. You can remove this page and blue lines*
- *Try to have the "most important" interviewees toward the end of your interviews series, so that you are best informed when meeting them. A good start can be your National Contact Points (NCPs) supporting Horizon Europe, in particular those for Clusters 5 and 6 (see https://horizoneuropencpportal.eu/)*

Conducting the interview

- *The interview is a **dialogue**, and this questionnaire offers a guideline:*
    - *Make sure you **know who you are interviewing** so you can either personalize the questions or skip some off them if the interviewee has no knowledge about these questions.*
    - *Mark the questions before the interview that you think are the most relevant for this interviewee.*
- *Let the interviewee react from **their field of expertise and experience,** but keep the conservation **focused on the CASRI themes and objectives.***
- ***Listen**, wrap up and ask for specifications if answers are vague/very generic.*
- ***Offer interviewees to have a look at your minutes/notes after the interview**, so that they can correct or add information and links to resources not available during the interview.*
- ***Thank** the interviewee for his/her/their time.*

A Introduction CASRI

CASRI is a 2.5-year European project with currently 14 involved countries. The Coordination and Support Action facilitates innovative sustainability research collaboration of Environmental Protection Agencies (EPAs), and similar partners across Europe towards new collaborative actions.

The main aim of CASRI is to enhance our understanding and address pressing environmental and sustainability challenges by bridging the gap between research silos, and between research, policy and practice.

To achieve this goal, over 18 EPAs and related organisations in Europe have joined forces. As part of CASRI, we are conducting interviews with National Key Stakeholders representing knowledge providers, research funders and end users. These interviews aim to identify the most critical knowledge and innovation needs and gaps for facilitating the environmental and sustainability transition. By gathering insights from stakeholders like you, we can develop a Strategic Research and Innovation Agenda (SRIA) that reflects the collective priorities of the environmental community. Additionally, we seek to uncover barriers and innovative solutions and actions to effective Science-Policy-Practice Interactions (SPPI) (how does the developed knowledge end up in policy and practice) and explore collaborative funding schemes to support the implementation of the CASRI SRIA by EPAs and other research funders.

CASRI works along 4 key environmental and sustainability themes that link several Sustainable Development Goals (SDGs) and that intersect the mayor existing funding foci of Horizon Europe: 1) Resilient, net-zero, circular production systems, 2) Biodiversity and Climate, 3) Sustainable urbanisation, 4) Nature & Environmental Friendly Energy Transition. When zooming into actual areas, these 4 themes meet each other, e.g. in the use of land or by being impacted by megatrends, such as digitalization. Trade-offs between them can hamper, but synergies between them can support obtaining the goals of a sustainability transition in all of these themes. Through your input, we can identify new challenges and opportunities for innovation within the themes, but especially on the cutting edges between them, and ensure that our efforts align with the broader goals of sustainability so that new challenges that request new knowledge, innovations, adapted policy and practice can emerge. By participating in this interview, you will contribute to shaping the future of environmental research and policy in Europe facilitated by the EPAs and their partners.

B Interview information & Background information interviewee

All to be filled out beforehand and quickly check with the interviewee:

Country:

Name of National Key Stakeholder (NKS) / interviewee:

Organisation / role:

Name of CASRI National Contact (NC) / interviewer:

Date of interview:

In the table below, multiple boxes can be ticked.

1. What kind of organisation can the interviewee's employer be classified? ☐ National authority ☐ Regional authority ☐ Local authority ☐ Environmental Protection Agency ☐ (applied) Research institute	**2. The interviewee's organisation can be classified as a:** ☐ Research and Innovation funder with a focus on ☐ environmental research and innovation

□ University □ Consultant □ Small and Medium-sized Enterprise □ Large enterprises (over 250 employees) □ Non-Governmental Organisation □ Sector association □ Network organisation □ other, ……..	□ sustainability research and innovation □ transformation research and innovation □ Science-Policy-Practice interaction □ Other: …….. □ No specific focus □ Knowledge consumer/end-user □ Knowledge provider □ Other,……..

C Background information interviewee

Q5 to be filled in beforehand.

3. What is your current position and responsibility regarding Environmental and Sustainability Research and Innovation (ES R&I), and how long have you held this position?

4. Please, describe your field of expertise in three keywords or topics.

5. Because of the need for focus, we identified 4 environmental and sustainability research and innovation themes for the CASRI project. **Which of these CASRI themes align most closely with your area of expertise?**
Fill in beforehand and check with the interviewee, interviewers can use the table below if you need to explain.

	Themes	**NKS Remarks** (if any)
ϒ	**Resilient, net-zero, circular production systems:** *Transforming Europe's production system from a linear, fossil-based system to one that is resilient, emission neutral and circular within the next few decades.*	
ϒ	**Biodiversity and Climate:** *Climate change accelerates biodiversity loss. Challenged ecosystems undermine nature's ability to regulate emissions. Potential exists in the interlinkages between the climate, biodiversity and pollution.*	
ϒ	**Sustainable urbanisation**: *Climate protection, land management, circularity and nature protection impact the quality of life in cities.*	
ϒ	**Nature and Environmental Friendly Energy Transition**: *Biomass, solar, wind, hydropower and links to broader societal issues (energy consumption for food, transport, tourism etc.).*	
ϒ	**Other/Crosscutting themes** (if any):	

6. For CASRI it is important to also map relevant networks on CASRI themes –**Which national or international networks do you regard as most relevant related to cutting edge environment and sustainability research and innovation?** (If you like to share: in which are you an active member e.g. by: membership, visit meetings, follow newsletters and publications, etc.)

D Collecting input for a Strategic Research and Innovation Agenda – getting insight in the State of the Art and Outlook

Within CASRI we aim to setup a Strategic Research and Innovation Agenda that addresses common R&I gaps for environment and sustainability transition. As a starting point, we focus on the mentioned CASRI themes and their cutting edges and shared drivers.

Q7 to be filled in beforehand.

State of the art

7. Please review this list of Research & Innovation Agendas/Programmes identified: **Which (Strategic) Research and Innovation Agendas/Programmes do you consider to be most important/ impact full and why** (e.g. it is linked to most resources, it requires innovative project formats, it addresses SPPI, …) (related to the CASRI themes, that are in your field(s) of expertise)**? Are important agendas missing** - please provide us with references (url, author of SRIA, etc).
   Use the desk study to prepare the list before the interview and supplement the desk study with additions from the interviewee.

(Strategic) Research and Innovation Agendas/Programmes	**Level** Regional (sub national) [R] National [N] Europe [E}] International [I]l	**Most important/impactful and why**

Outlook

8. **Now, consider you can put up to 5 specific research and innovation priorities to the SRIA, which will be implemented by the EPAs and partners: Which R&I priorities would you set and which impact can be achieved by a focus on these priorities short- and long-term?** When possible, can you provide us with references?
   Use the table on the next page

More detail may be added if this comes up in the conversation (e.g. stakeholders to attract, connected outputs and outcomes, above mentioned references).

R&I Priorities – and why urgent and/or important?	**What impact is expected to be achieved by focusing on these priorities? Mention the term (short term < 10 years, long term >20 years)**	**On what level will this impact take place?** Regional [R] National [N] European [E] International [I]l

E Funding

CASRI brings together EPAs of which some have own research funds. We seek promising collaborative funding schemes between the EPAs and in collaboration with other ES R&I funders to implement the CASRI SRIA.

*Q9 to be filled in beforehand. - Go through Q 12-13 **only** if fitting with the interviewee.*

State of the art

9. Which are the current funding schemes / organisations that you consider most relevant (Predominantly used as well as promising alternative funding schemes / mechanisms / programs for knowledge production and dissemination in your own field and other fields of expertise) which can offer opportunities – think about both public and private funding schemes/organisations). **Are funding schemes missing?**

Use the desk study to prepare this list for different levels before the interview and supplement the desk study results with additions from the interviewee.

Relevant Funding Schemes	Level Regional (sub national) [R] National [N] Europe [E}] International [I]I	Most relevant? Why?

10. Which collaborative funding scheme (meaning multiple funding organisations are involved – can be national, transnational, public/private, etc.) **do you regard as most effective in terms of knowledge production and dissemination and why?** What factors have made this type of funding scheme a success?

11. Which thematic areas in your field of expertise are poorly or not at all covered by current funding instruments or programmes? Use here the research priorities of Q8.

Outlook - Ideas regarding the use of any (transnational) pooled budget for the scope of CASRI

12. Consider again your R&I priorities: **What do you recommend to consider in setting up/govern <u>future</u> funding option(s) for the CASRI SRIA** so that the expected impact can be achieved?

13. **What elements of justification are needed to convince your national funders to become part of a cross-national funding scheme** such as the one that CASRI is aiming to set up? Please be as specific as possible.

F ES-R&I-Science-Policy-Practice interaction

EPAs are traditionally strong actors linking scientific research and policy-making through providing data and evidence-based policy advise, and information for the public and economy to spur environmentally friendly decision making and sustainable production and consumption patterns. Being aware of the importance of effective SPPI / the interaction between science – policy and practice, we request your view on how to improve that new environmental and sustainability knowledge and innovations are taken up in policy and practice.

14. **Please describe what the interaction between science – policy and practice looks like in your work?**

15. **Please describe what activities and/or organisations in your field of expertise effectively facilitate the interaction between science – policy and practice?** How are you involved in these?

16. **What are the main challenges for this/these activities and/or organisations at the moment? What can be reinforced or improved?** Or should other science policy structures and activities be developed?

*Go through Q 17 **only** if fitting with the interviewee (more experience with SPI)*

17. OPTIONAL QUESTION: ONLY SSPI EXPERIENCED PEOPLE: **Which of the following capacities are needed in order to improve the interaction between science – policy and practice in your country and internationally?** And why? When possible, can you also indicate which types of organisations should work on these capacities?

Capacities for evidence informed policies*	National	International
1. **Synthesizing research**: employ methods to make better sense of the wealth of knowledge available on a given topic, particularly when driven by a research question co-produced with policymakers.		
2. **Managing expert communities**: communities of experts, sharing a common language or understanding, are fundamental to applying knowledge to complex problems. Effective teams develop facilitation skills to reduce disciplinary and policy divides.		
3. **Understanding policy:** seek to better understand the policy process, which can never be as simple as a policy cycle with linear stages. Effective teams adapt their strategies to a messier context.		
4. **Interpersonal skills:** effective actors are able to interact well with others in teams to help solve problems.		
5. **Engaging with citizens and stakeholders:** well-planned engagement with stakeholders, including citizens, can help combine scientific expertise with other types of knowledge to increase their relevance and impact.		
6. **Communicating scientific knowledge**: impact requires effective communication skills, from content-related tools like infographic design and data visualisation, to listening and understanding your audience.		
7. **Monitoring and evaluation:** monitoring and evaluating the impact of research evidence on policymaking helps improve the influence of evidence on policymaking.		
8. **Advising policymakers:** effective knowledge brokerage goes beyond simply communicating research evidence, towards identifying options, helping policymakers understand the likely impact of choices, and providing policy advice from a scientific viewpoint.		

**Capacities taken from the EEA publication Knowledge for Action – Based on the JRC publication: Topp, L., Mair, D., Smillie, L., & Cairney, P. (2018). Knowledge management for policy impact: the case of the European Commission's Joint Research Centre. Palgrave Communications, 4(1), 1-10.)*

G Other aspects and ending the interview

18. Do you have (other) points of attention for CASRI when developing the Strategic Research and Innovation Agenda, funding options or the science-policy interface?

19. Can you recommend individuals who may have an interest in CASRI and/or should be interviewed? (optional)

20. We will collect the information from this interview and the other interviews in a draft national report. This national assessment will be discussed in a national workshop scheduled for September this year. The workshop will review the condensed collection and help us identify national priorities before results are entering a next transnational synthesis phase in order to identify shared topics.
Would you like us to keep you updated about CASRI and are you interested to be involved in the next stages?

- ☐ YES, keep me updated.
- ☐ YES, I (someone of my organisation) like to participate in the national workshop.
- ☐ YES, I have a strong interest to co-design the transnational common topics.
- ☐ YES, I am interested to exchange about and explore funding options for the CASRI SRIA.
- ☐ YES, I like …
- ☐ NO

21. Do you have further questions or suggestions arising from this interview?

OPTIONAL:

If appropriate and fitting:

- Invite the interviewee to join the LinkedIn group where discussions on CASRI themes will take place: https://www.linkedin.com/groups/12905562/

Ask the interviewee what he/she/they see as the added value of CASRI for them.

Appendix D: Generic workshop programme

This workshop program as provided to the NCs. However, NC's were free to adapt the program to their specific situation (country-specific habits, resources available etc.).

Introduction

As described in CASRI Task 2.3, you, as one of the National Contacts (NC) are to organise a national NKS workshop in which:

1) the information from the desk study and interviews is *reviewed*, *synthesised* and *prioritised* (**content**), and;
2) NKS' **commitment** to CASRI is enhanced.

Regarding **content**: Note that the workshop will benefit from your good preparation. Aim at presenting and discussing clustered results and seek confirmation or refinement and finally prioritisation of the results for your country or region. Ideally, remind the participants of the relevant context characterized by stressors and accelerators linked to future challenges like those suggested by the international Advisory Board[31] and EEA[32].

Regarding **commitment**: Our aim is that NKS feel as co-owners of the CASRI process and have an interest to follow on the next steps of the shaping of the SRIA. Moreover, NKS who are potential funders should feel considered regarding their demands – but note that the workshop is mostly on content, and funding will be a focus of a later project stage. 4 NKS per country shall be identified in or after the workshop to closely act as a type of national sounding board for the further SRIA development and implantation steps. All NKS are invited to stay in touch and get updated, e.g. through CASRI website and social media.

With these two objectives in mind, this memo proposes a generic programme for your workshop. The programme should be seen as a starting point for the actual workshop, which should be tailored to your specific national context (e.g. regarding the number of NKS participating, the specific CASRI themes covered in the desk study and interview phase, and practical issues such as the available facilitators, the venue etc).

Context and planning

As figure 1 shows, the workshop is to be held somewhere in August-September (or early October). It is an essential part of Task 2.3: Review and synthesise the collated information. The main background for the workshop is your interim national report (deadline July 31 or at least 2 weeks before the workshop) which is in turn based on your national desk study and interviews. For the workshop participants, a shortened version, may be distributed beforehand and presented at the workshop (e.g. focussing on the top 15 clustered research gap and some areas of doubtful research areas; SPPI main lessons and a very brief conclusion on best practice for funding).

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[31] *The challenges put forward by the IAB: 1) Societal transitions and behavioural change; 2) Artificial intelligence (AI); 3) Green transitions and associated dilemmas; 4) the outcome of the European elections.*

[32] *The polycrisis: the convergence of economic, social, geopolitical and environmental crises which together create systemic risks to the world as we know it.*

The main output: Workshop results feeding into a draft national report consisting of your country's comprehensively reviewed ES R&I needs, SPPI challenges/opportunities and funding options (hard delivery deadline: Oct 18).
The WP2 lead will have these draft reports reviewed and will collate them in one final document: Deliverable D2.1 (M11, 30 Nov).

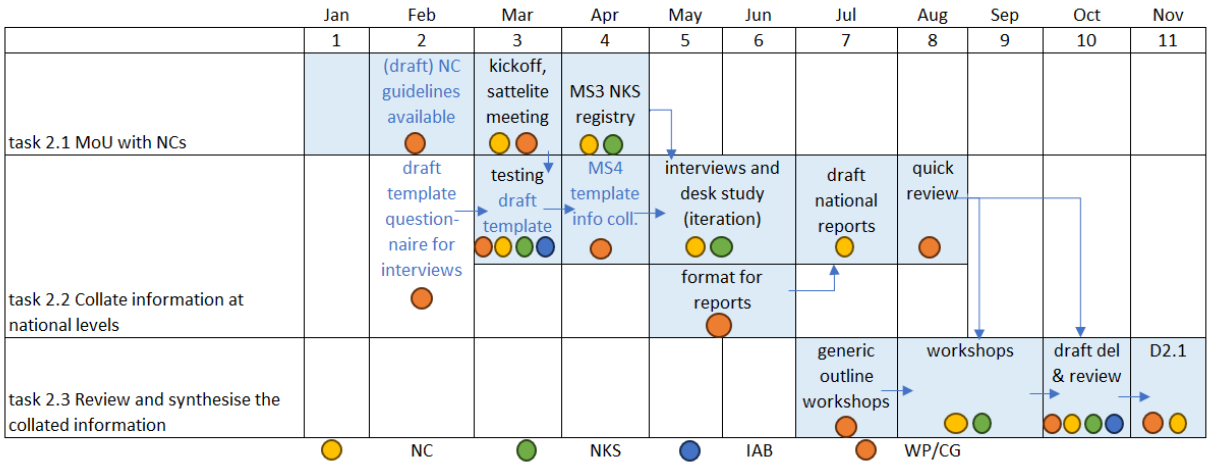

FIGURE 1: CONTEXT & PLANNING

Workshop Agenda

Table 1 proposes a generic agenda for your workshop. Use it in a flexible way. You can, for instance, start with an afternoon session (PART 1) followed by a dinner (for networking and commitment) and a morning session (PART 2) on the next day. An alternative would be to start PART 1 in the morning and, after a lunch, continue with PART 2 in the afternoon, thus fitting both parts in one single day. You may change the length of the different aspects. The most effective way to shorten the programme would be to cut back the number of rounds in the various world café[33] parts in the schedule. Main point is that you ensure that both content and commitment are addressed sufficiently.

PART 1: Review, synthesize and prioritize the Environmental and Sustainability R&I needs and gaps

Time	Activity	Goal/questions	Set-up (suggestions)
'30	**Walk-in** and registration (lunch or coffee/tea and cookies)	Networking/ commitment	Registration form, where people confirm their presence by a signature and if you take pictures (recommended) add a form where they consent that we can take and use the pictures on our website/social media

[33] *In the world café setting, we have several tables, each with a different theme and a facilitator. Small groups of people discuss this theme around a specific question in a set time. The discussion is reported on a poster / flipover (eg by the facilitator or using post-its) so that everybody can see it. After the set time, each group member goes to a next table to discuss another theme. The table facilitator gives the new group a short wrap-up of the discussion held (using the poster/flipover), so the new group can react on this and build upon this … etc. You can find more explanation on this method using internet.*

Time	Activity	Goal/questions	Set-up (suggestions)
'30	**Welcome**, today's goal, introduction to the agenda and the CASRI project (bottom-up informed SRIA, EPA network to implement innovative ES R&I based on real needs; CASRI triangle, SPPI)	Inform	plenary presentation by NC
'20	Brief **presentation** summarizing the results of the desk study & interviews regarding the country's Environmental and Sustainability R&I needs and gaps		
'60	**World Café: reviewing** the four CASRI themes in 2 rounds: ➢ Round 1 (30 minutes to discuss theme of greatest expertise) ➢ Round 2 (30 minutes to discuss second most relevant theme: start with summary of round 1 by table leader followed by discussion)	Content *-Did we miss anything? (also note 'new' crosscutting themes on a separate paper)* *-Should we remove things?* *-Are there areas where participants strongly agree or disagree?*	4 theme tables, with 1 fixed facilitator (NC or NC co-worker) per table. Good to prepare a poster with ES R&I clustered gaps and needs from the interim report (i.e. review and interviews). Small groups of NKS visit these tables in 2 rounds and review the ES R&I gaps and needs. NKS choose a start topic, where they feel to have greatest expertise in the 1st round, and the second most important theme for them in the 2nd round. Alternatives to this world café setting: -Plenary discussion -NKS walk around, applying post-its to theme-posters or have packing paper on the tables and various pens, so participants can scribble on one large sheet, draw lines
'30	Coffee/tea	Networking/commitment	
'30	Main outcomes of discussion per theme and mentioning of any new crosscutting issues	Content – get all on the same page	Theme table facilitators round 1 present max 5 min per theme with some time for reactions
'15	**Synthesizing & prioritizing by NKS of** the four CASRI themes (and if topics came up: also for the new or crosscutting themes) **by applying sticky dots**	Content *-What should be the focus for the CASRI theme* (most important)*?* *-Are there any areas where participants*	-Individual NKS get each 10 sticky dots and apply stickers to the most important topics (several dots for one topic is possible) on the theme-posters (of their choice) to choose and prioritize topics. Alternatives settings:

Time	Activity	Goal/questions	Set-up (suggestions)
		strongly agree or disagree?	-Plenary discussion -world café (same) 4 theme-tables, with 1 same facilitators (NC or NC co-worker) per table. Small groups of NKS visit the tables in 2 rounds of 20 minutes each. NKS again choose 2 themes/tables (not necessarily the same) in total to select main ES R&I gaps and needs (most urgent and important).
‘50	**Guided discussion on prioritisation:** ➢ What do we see as most important topics and why? ➢ Do we have it all, what is important for us to add to the SRIA?	Content	plenary discussion, led by NC (assisted by facilitators) 10 minutes per theme and 10 minutes for new/crosscutting themes
‘5	**Closure** (incl explanation next part) part I		Plenary by NC
	Drinks & snacks and/or joint diner/lunch	Networking /commitment	

PART 2: Future challenges, Science Practice Policy Interface & Promising funding schemes

Time	Activity	Goal/questions	Set-up (suggestions)
’30	**Walk-in** and registration (lunch or coffee/tea and cookies)	Networking /commitment	If this is a second day: use again a registration and consent for pictures form
‘10	**Welcome** back, today’s goal, introduction to the programme	Inform	Plenary presentation by NC
‘30	Brief **presentation** summarizing the results of the desk study & interviews regarding SSPI and funding		
‘20	**Pitches** of **stressors & accelerators:** future developments and challenges that could stress or accelerate ES R&I needs, SPPI improvements & Funding Schemes identified in the national review or by IAB[1] and EEA[2], e.g.: ➢ Artificial Intelligence (AI) ➢ Resource conflicts: over land, water etc. ➢ Polycrisis Etc.	Inspire, opening the discussion	Plenary, via: -Sheets (prepared by CASRI) presented by NC or NC co-worker, and/or -Short introductory movies (by EEA, IAB) (*t.b.d. note that the number of stressors / accelerators is not defined at this moment*)
‘30	**Plenary discussion: stressors & accelerators** Do we see other stressors and accelerators? What might these stressors & accelerators mean forES R&I needs (SRIA) of the future? ➢ Promising Funding Schemes	Content *Focus on future challenges and what this means for EPAs / R&I needs*	Plenary discussion, with a moderator (NC or NC co-worker) and note taker. Alternative: when you have a lot of NKS, divide in 2 or 3 groups.
‘30	**Plenary discussion: challenges for the science policy practice interaction** ➢ What are challenges for the science policy practice interaction and do these new stressors and accelerators change the situation? ➢ What does this mean for our way of working? (science policy practice interaction)	Content *Focus on current and future challenges and what this means for EPAs / (research) collaboration*	See above
‘30	Coffee/tea	Networking /commitment	
‘30	**Plenary discussion: funding needs and opportunities** ➢ What do we see as funding needs and promising funding opportunities currently and in the light of these new stressors and accelerators? ➢ Do we need to change the funding for E&S R&I?	Content *Focus on current and future challenges and what this means for EPAs / (research) funding needs and opportunities*	See above
‘25	**Wrap-up**	Content	Presentation NC, or NC co-worker, plenary

Time	Activity	Goal/questions	Set-up (suggestions)
		-What can we conclude and what are the main take aways regarding the themes and topics, SPPI and funding opportunities?	
‘25	Next steps and stay involved: ➢ Present next steps and invite NKS to stay involvedin CASRI ➢ Ask NKS what the conditions are for them to stay involved. ➢ Allow for time for questions	Commitment	Presentation by NC (max 10 minutes) Collect needs/demands from NKS to stay informed/involved (NC = moderator, co-worker writes conditions on flipover). If you do not know answers on questions, write them down and send answers later
‘10	**Closure**: & farewell		NC, or NC co-worker, plenary
	Drinks & snacks and/or joint diner/lunch	Networking /commitment	

TABLE 1: WORKSHOP PROGRAMME

Appendix E: Final review from the International Advisory Board (IAB)

The IAB was asked to reflect on the report using three questions. Their input is presented below.

Question 1: What insights on the current report do you wish to share with the CASRI project team?

- In 1.1, the report states that "The SRIA is meant to become a guiding document for the national EPAs involved in the project" - While this is undoubtedly true, I hope the SRIA would become more than a document, but a mindset and a guiding principle for SRIA-led development of strategic directions for EPAs and other players in the environment & sustainability domain. There are a number of insights related to the general approach of CASRI, and the individual country reports, which presents a wealth of information in a fairly accessible manner."
- WP2 really served as a classic state-of-the-art review for CASRI's national teams. That's absolutely fine in order for everyone to dive in to the status quo and also to find a common language and methodology to analyse the topics and learn from each other. With EPAs having very different roles, mandates, resources and governance in the different Member States the work done in WP2 surely helped everyone to get a grasp of the topics CASRI has been focussing on until now as well as the relevant national/EU R&I funding landscapes.
- I consider this report and the related datasets to be an impressive foundation for the next steps of the CASRI project. The National Contacts have collected a huge amount of data through the interviews and structured workshops. The report provides a good overview of the project's objectives and the work done so far.

Question 2: What recommendations would you make to the CASRI project team regarding the next steps for the CASRI project?

- I would consider much value to be in the comparative analyses of the individual country reports, drawing out similarities, differences, and then perhaps in following up in a second round of targeted engagements to build on these analyses and draw out, which similarities and differences in setup, structure and approach in the nations may provide us with insights into what works best/better, and where particular barriers are identified.
- Given the valuable insights across a lot of countries with different institutional and governance setups, this would - in my opinion - present significant added value for the derivation of SRIAs not just for individual countries or national players, but as well inform where future SDGs or EU Horizon 10, 11 and beyond may evolve into. And last, but not least, this could serve as a platform to engage with other countries outside of Europe, as the questions addressed in developing the SRIA are fairly universal and in some shape or form need to be addressed outside of Europe as well?
- Celebrate finishing WP2, leave it behind you and now focus on the PURPOSE of WP3 (influenced by the WHY of CASRI). Really rethink what you want to achieve with this WP. Is it still the same compared to when you wrote the proposal? What to keep? What to change?
- Think about the purpose of a SRIA (e.g. https://www.era-learn.eu/support-for-partnerships/cross-cutting-issues-and-additional-activities/strategy-and-foresight/what-is-a-sria) and then really put down in writing what a CASRI SRIA should be for EPAs. What should

the impact of a CASRI SRIA be? Make this extremely clear, make it ready for executive approval (i.e. SHORT) and present it to EPA Heads asap to get leadership commitment for the now decisive phase CASRI enters into.

- Focus on common EPA challenges in your agencies' R&I in the context of a changing policy landscape, geopolitical upheavals, uncertain Science-Policy-Interfaces, public scepticism and mistrust towards expert advice, a changing Green Deal etc.
- I would like to ask whether the identification of "transnational commons" and finally the construction of common SRIA is intended to strictly adhere to the four predetermined themes. The national reports highlighted potential additional themes or questions that combine the given themes. How are you planning to take those new ideas into consideration? Is it possible to add/abandon themes if appropriate on the basis of national reports? From the beginning, it has been somewhat unclear to me what kind of a process led to the selection of these four predetermined themes. The CASRI project proposal did briefly describe and justify the selection of the themes, but I would appreciate a deeper analysis/documentation on the benefits or drawbacks of the use of these predetermined themes as compared to free ideation.

Question 3: Do you have other remarks about or suggestions for this report or for the CASRI project in general?

- A general point I have made before is that of the interconnectedness of crises, i.e. the focus in this report is on ""climate change & biodiversity"", but we are facing at the very least a triple crises (adding environmental degradation/pollution) and we could likely map out the wider complexity e.g. including land degradation as well. But what is equally not as strongly addressed - likely owing to the fact that it is focused on EPAs - is that sustainability has three core dimensions: ecological, social/societal and economic. If feasible, the discussion of the three dimensions of sustainability, as well as the interconnectedness of the multi-crises could be the defining element where CASRI and the development of SRIAs leads the way towards a systematic, holistic framework for identifying the key aspects at different geographic and governances levels that absolutely have to be tackled, and how international and multi-level governance cooperation can be utilised to achieve this.
- As the members of IAB have stated already before, I also ask the CASRI project to be ambitious. Building a common ES SRIA with its implementation plan and measures is an ambitious goal as such. But the data that all the national contacts have already collected gives opportunities to several other activities. I know that the CASRI action plan includes the communication and dissemination plan, as well as ideas on writing scientific peer-reviewed papers. But could CASRI already take a visible stand in favour of environmental and sustainability perspectives, as they are being seriously questioned in Europe and around the world.

Appendix F: Final review from the National key Stakeholders

At the start of 2025, in the review phase of this deliverable, the NKS (1-4 from each country) were asked to correct any factual errors in their country report, and to reflect on the report using two questions. In total 13 NKS filled out the review form, i.e. from Belgium (1), Bulgaria (4), Finland (2), France (2), Italy (2), Montenegro (1), The Netherlands (1). The factual corrections are integrated in the country reports above. The input on the two questions is presented below.

Question 1: what recommendations would you like to give to the CASRI project team when it comes to the next steps for the CASRI project?

- The report was really good, hopefully it is used! In the Finnish report, it is stated: 'The plan published in June 2024 indicates a process led by the Research and Innovation Council under the Prime Minister Office to form strategic direction of choices (Valtioneuvosto 2024, 30)." The situation now: these choices will be made during spring 2025. There will be possibilities to influence these choices, hopefully CASRI team in Finland uses these possibilities, and contributes to the process.
- When presenting project activities and next steps, it would be good to have a wide stakeholder meeting in order to identify synergies on both national and local level for future activities.
- Promote nexus assessment (see https://www.ipbes.net/nexus/media-release) of policies also for designing new ones: sectorial policy are deemed to fail. Policy making should be revolutionised and R&I can help and show the way.
- Promote the culture of cross-sectorial approach among policy makers and implementers through training and capacity building initiatives. Develop (training) tools to favour this.
- Effective uptake of research and innovation by small and big enterprises and by society is a crucial topic to be further developed.
- CASRI has great potential, but to make a real long-term impact, regional and cross-border collaboration needs to be strengthened, especially in the Balkans and the Danube region. Flexible funding is key—programs like Interreg Europe and Horizon Europe should be better adapted to be more accessible for Bulgarian institutions. The existing gap between science and industry is another important challenge — there is a necessity of incentives for partnerships through dedicated innovation programs, public-private collaborations. Public engagement is considered as important issue, too – more citizen science platforms, better communication, and interactive tools that make project results more accessible to a wider audience are necessary. In this, CASRI could promote open data access and collaborate with national statistical institutions for more precise monitoring.
- I have appreciated the process and the workflow and I share the points of attention and recommendations in our national chapter (Italy). I would only focus even more on the need for coordination both within and among institutions, which is critical to reduce fragmentation and enhance collaboration and synergy and on the intrinsically connected need for openness of information, data and all products of science for societies.
- Effective lobbying to promote CASRI results in public policy, without underestimating the time and skills required: communication, advocacy, political support, opinion leaders, etc. Calling

for a post-CASRI follow-up program: what follows, how, who? And thank you for keeping participants informed.

- One thing CASRI should really think about for the future is how to keep the momentum going beyond the project's official funding period. Right now, there's a lot of valuable work being done, but without a solid structure to carry it forward, there's a risk that the results won't have the long-term impact they could. A good solution would be to set up a permanent CASRI Coordination Office or Secretariat—something that could serve as a hub for connecting researchers, policymakers, and industry leaders even after the project officially ends.
- I can point to several recommendations for the next steps of the CASRI team. It is advisable to: i) continue the strengthening collaboration for sustainable funding aiming for sustainable development in Europe in times of multiple crises; ii) to develop current R&I infrastructure and research potential by engagement in EU-funded projects and to reduce bureaucratic inefficiencies and gaps in the commercialization of innovations; iii) continue the good practices achieved by now on discovering the research and innovations needed to transform the (European) industrial value chain financed through EU instruments and individual countries.
- In my view, there's a big gap in the framing of CASRI and how things are moving forward in real life (geopolitics). In the next phase, I would emphasize the dimensions of political economy and security – or how to bring sustainability research and innovation to the core of today's policy-making.

Question 2: is there something else you want to tell or ask the CASRI Project team?

- Interesting work and very important. Please share the final report with the Dutch Ministries responsible for these policies.
- I'm happy to give more information on how to influence the strategic choices that will be done in Finland during spring/summer 2025. The CASRI project has good timing!
- I suggest including the National Council for Sustainable Development, an advisory body to the Government of Montenegro, along with its expert working groups, in the decision-making process. This council serves as an excellent platform for information exchange, enhancing stakeholder engagement, and fostering intersectoral cooperation. Its involvement can contribute to better promotion of the concept, identification of synergies with other national and local initiatives, and overall improvement of sustainability efforts.
- Connect the CASRI project with other current medium-long term valuable initiatives such as Biodiversity. Try all means to leave a legacy, don't let this valuable effort to drop after the end of project, please
- I could state that CASRI has already gathered a strong foundation of knowledge and collaborations, and the most important challenge in the near future will be to turn this knowledge into real actions. The next steps should focus on implementation, impact measurement, and ensuring long-term sustainability for CASRI's mission.
- Congratulations on this very useful project, with the hope that it will shed light on the forks in the road needed for a genuine ecological transition. And bravo to the French team for this very pertinent vision of the national system!

- Will there be additional opportunities (workshops, advisory groups, joint initiatives) for stakeholders to provide input and collaborate beyond the initial consultations?
- Supporting sustainable, zero-carbon, and circular production systems is essential for the transformation of the economy from a fossil-based to a carbon-neutral and circular economy in the coming decades. The results so far show that the successful implementation of various objective policies requires paying greater attention to the links between science, economy and society to achieve sustainability.
- Climate change and biodiversity loss are deeply interconnected global challenges. The CASRI team has made significant progress in understanding change and has noted its importance for ecosystem resilience, its impact on agriculture and fisheries, and the livelihoods of many communities. Biodiversity loss is both significant because of the potential for synergistic solutions and the risk of trade-offs. The development of strategies to combat climate change, conserve biodiversity, and develop nature-based solutions to address these issues must continue to evolve and grow.
- The CASRI team has an excellent strategy in the field of sustainable urbanization and the development of the different sectors involved in the planning, construction, and maintenance of urban centres. It focuses on aspects such as climate protection, climate adaptation, provision of recreational areas, promotion of urban nature, improvement of air quality, as well as reduction of noise pollution. These goals are linked to human health, to social aspects such as community identity, participation, and quality of life, as well as to environmental, social, and economic impact. Good practices must continue to be developed.
- CASRI's strategy for transition to nature- and environmentally friendly energy systems reflects a systematic approach to a nature- and environmentally friendly energy transition. The development of priorities in the energy transition, such as the integration of expert advice to address target conflicts and ensure regulatory compliance, is well outlined. The team's efforts to develop a code of conduct on how to deal with topics such as "Energy Transition", which include conflicts of interest, and possible scenarios for impacting the development of the energy transition at the regional level, e.g. cities and municipalities, are to be welcomed. The development of this methodology is of utmost importance, as it can subsequently be transferred to larger scale levels. CASRI should continue its preliminary research on the topic of nature- and environmentally friendly energy transition.
- Thanks for important cross-national thinking!

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